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Contents.

	PAGE
Where can the Maximum Economy in Foundry Practice be Effected	63
Institute of British Foundrymen	64, 80
Gazette	65
Correspondence	65, 81
A Review of the Physical Properties Involved in a Study of Moulding and Foundry Sands	66
Some of the Factors which Influence the Strength of Cast Iron	67
Designing a 4-ton Cupola	71
Shop Trials of Diesel Engine at Wallsend Works	72
Catalogue Received	72
Selling Castings.—VII	73
A New Method of Measuring the Hardness of Moulds	74
Foundry Work and the Draughtsman	75
Powdered Coal in a Malleable Casting Plant	78
Cleaning Castings.—I	79
Table Talk	82
Company News	82
Personal	82
Contracts Open	82
Obituary	82
Iron and Steel Markets	84

Forthcoming Events.

JANUARY 23.

Institute of Mechanical Engineers:—General meeting in London.

Junior Institute of Engineers:—Lecturette in London. "Boiler-House Records and Their Practical Value," by R. H. Parsons.

JANUARY 24.

Institute of British Foundrymen (London Branch):—Ordinary meeting in London. "Some Innovations in Microscopy of Metals," Paper by Dr. Rodgers.

Stoke-on-Trent Association of Engineers:—Ordinary meeting at Hanley. "The Industrial Uses of Compressed Air," Paper by Andrew Stewart.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Where Can the Maximum Economy in Foundry Practice be Effected?

Generally speaking, there is but one answer to the above question, that is, the greatest economy in foundry practice is to be effected by the installation of mechanical handling devices. It has been stated that the manufacture of 1 ton of grey-iron castings involves 168 tons of material, so that in a malleable iron shop this figure would reach well over 200 tons. Here, then, is a profitable field for investigation for every foundry. It is probable that most men making such a study would recommend the erection of an entirely new foundry.

The unloading of the raw materials up to their charging into the furnace can be reduced to one operation by taking the trucks up an inclined track into a revolving cage above the charging hole and tipping the whole of the contents direct in the cupola. Obviously, no cupola would stand such treatment, but between that elementary system and the worst method we have encountered, which consists of carting the raw material from the siding, stacking it, carrying it up by hand to the cupola staging, weighing, and re-stacking and charging into the cupola, there are several alternative courses which save much of the handling.

The handling of sand is possibly an even more difficult problem, as the conveying of damp sand ruins most types of conveyors. However, the Americans seem to have overcome the difficulty, though contradictory reports are inclined to shake the confidence of the average British foundrymen. Crane-handled boxes with mechanically-opening bottoms, used in conjunction with overhead storage tanks feeding directly into the machines is perhaps the best system so far devised which fits into British practice. Core ovens with moving grates arranged in such a way as to facilitate continuous handling can effect considerable economies, but such a system demands a considerable quantity of cores falling within somewhat restricted weight limits.

The reduction of wasters is not so serious as perhaps some owners imagine. On the authority of Dr. Moldenke, we are in a position to state that one of the largest foundries in the world makes 25 per cent. wasters, and still is prosperous. The larger the output of any foundry the more important becomes the handling question and the less (though still of course very serious) the question of wasters.

Coke economy we have previously dealt with, and its importance can be summarised by stating that for the cheapest type of castings produced on a quantity production basis it is of the greatest importance; but for expensive speciality jobs it falls into insignificance.

The metallurgical control of a foundry by checking wasteful buying; refusal of raw materials when not fulfilling specification; reducing the waster bill; improving the product and economising the sand bill, can effect considerable economies.

Summarised for British foundry practice one looks for the greatest economies in the following directions—for the largest foundries, mechanical handling; for medium-sized foundries, metallurgical control; and for the smallest, machine moulding. However, before most of the foundries of Great Britain can receive the maximum benefit from any effort at economising the costs of production, they must institute a proper costing system.

XUM

Institute of British Foundrymen.

Annual Dinner of Scottish Branch.

The annual dinner was held in the Grosvenor Restaurant, Glasgow, on January 10, and was attended by a large number of members and others. Mr. James Affleck, B.Sc., President of the Scottish Branch, occupied the chair, and among those present were Sir Archibald McInnes Shaw, Mr. R. O. Patterson, President of the Institute, Mr. Cameron, President-elect, Mr. J. G. Pearce, director of the British Cast Iron Research Association, Mr. John Bell, Secretary of the Scottish Branch of the Institute, and Professor Mellanby.

SIR ARCHIBALD MCINNES SHAW, who proposed the toast of "Institute of British Foundrymen," said that one was struck sometimes with the great advances which were being made in every kind of work, and although he had been connected with a great many associations, he had never yet been a member of the Institute of British Foundrymen, although he was probably amongst the oldest foundrymen in the country. He knew that the Institute had done a tremendous amount of work in connection with the foundry industry, and it had also done the country good. Sir Archibald continued that he was once shown round a very fine and up-to-date foundry, designed for the production of pipes, the proprietor of which explained to him that they could turn out pipes all right but they could not make money. A great many of the big foundries which once existed in Glasgow had been closed down, and he had wondered what was the reason. It was probably because they were not near enough to the source of supply of pig-iron. The foundries which still existed had no doubt a certain advantage in being so near the Clyde, as they had the benefit of the facilities afforded there for the export of their goods. The latest foundry which had been established in Glasgow was a very big concern, and if it was in full working order, there would probably not be much room for many others, as it seemed big enough to turn out sufficient castings for all the shipyards on the Clyde. So far as the wages were concerned, a man received better wages in a foundry than in an engineering shop. The difficulty that faced the industry was that the trade unions turned round and said they did not want too many men in the trade. That, of course, was a very selfish attitude to take up. He had asked one of the founders present that evening if he could put on a double shift in his foundry, should he require to do so, and he had said he could not. Turning to another question connected with the industry, he said that Lord Weir had recently brought out a great scheme for the construction of steel houses. He (Sir Archibald) wanted to suggest to that important gathering of foundrymen that it would be a good thing to erect cast-iron houses. He knew a good deal about cast iron, and he knew that it lasted much longer than steel. In fact, some of them might think that it lasted too long. He had an uncle in the trade who, when once asked what was the life of a cast-iron pipe, replied that he considered the life of a cast-iron pipe was far too long for the average iron founder. (Laughter.)

Education of Workmen.

MR. PATTERSON replied on behalf of the Institute, and said that they were all very proud of it. It had done a good work, and had benefited the foundry industry at large. Among the branches, he thought that the Glasgow Branch had reason to be proud of the advance it had made. He could not agree that the industry was at all decadent in Glasgow, and he had no doubt that they would see something there in June next which would show how it flourished. The Institute, as they knew it, was out for the advancement of knowledge in the foundries, and for the improvement of the condition of the foundry worker. In this connection, he might mention that he thought they were up against a rather serious problem, and in many cases he must admit that he thought the problem would not be solved in the lifetime of the present generation. He did not know how it was, but many moulders, and particularly good moulders, were definitely conservative. He was speaking more especially of the older men in the foundry to-day, and nothing that they could do would alter the opinions of these men. Their lack of knowledge of the article which they were handling every day was really appalling. It seemed to him that the only thing they could do was to get hold of the younger men and teach them. Another thing they had to do was to try to ease the conditions in the foundry more than ever. The industry must get ahead with melting appliance, labour-saving machines, and other things. He did not think it was right for a man to spend half of his time shovelling sand which could be done by mechanical means. There were machines made which could do it and at the same time save cost. It would also allow the man to do actual finishing work on the mould. With regard to the application of science in the foundry, Mr. Patterson said that was a very important matter. He might say he was quite a recent convert in this matter. His first steps in that direction were taken by reading David McLain's course. He considered that work was worth its weight in gold to any foundryman, not because it was particularly brainy, but because it put things in such a way that if one went through that course he would not be satisfied but would want to know more. He might add that his firm had started a laboratory at their works. It was just a small affair, but it paid them. They had also joined the Cast Iron Research Association, and that paid them too. They were now in a position to apply any information they received from the Association to work in their own foundry. It was not possible perhaps for every foundry to run a laboratory, but it was quite possible for, say, half-a-dozen small foundries to run one jointly and to apply the knowledge they received to their individual works. It had given him great pleasure to be present that evening, and he wished the Glasgow Branch every possible success.

The toast of "The Guests" was proposed by MR. MEARNS, and PROFESSOR MELLANBY, in responding, in name of the guests thanked their hosts for their hospitality. Everyone agreed, he said, that the prosperity of the industry depended to a remarkable extent on the Institute, but he had often felt that it really did not exert its full benefit on the life of the community. The prosperity and happiness of the community depended to a very large extent on technical things. If they took the latest development—that for the introduction of smokeless fuel—they found that the scientific institutions had been advocating that step for about 20 years, and imploring corporations to take up the matter. He was pleased to say that Glasgow was the first large city to do so. There were many other problems to tackle, however, such as their wretched suburban railway services. How much could be done by the electrification of the suburban railways?

Importance of Foundry Trade.

MR. J. C. PRIMROSE, Falkirk, proposed "The Scottish Branch," and the Chairman, in replying, referred to the absence of Mr. Hollinworth, who, he said, had been stricken with a serious illness. In name of the members he proposed to send to Mr. Hollinworth a message expressing their sympathy and wishing him a speedy recovery. Referring to the present condition of the foundry trade, Mr. Affleck said they wanted to train the right kind of men for the trade. They wanted to interest young men in it who would raise up the foundry trade from the kind of Cinderella position it had fallen into, and bring it into line with other branches of the mechanical art. He had been associated more particularly with the scientific side of the work in the foundry, and he knew that the savings it had effected were many times the expenditure incurred. But it was science of the right kind—not the "high-brow" type. It

was science that could be related to work. He could assure their President, Mr. Patterson, and their President-elect, Mr. Cameron, that the Scottish Branch of the Institute would do its utmost to maintain the best traditions of the foundry trade. They would strive to realise the motto to which attention had been drawn, by combining science with labour. (Applause.)

The Research Association.

MR. CAMERON, who proposed "Success to the Cast Iron Research Association," said the work of the Association had now been carried on for some years, and he had been a member of the Council since the beginning. For the first few years, perhaps, they did not get full value for their money, but he was convinced that the Research Association was on a very different footing now. Not only was it going into matters from the theoretical point of view, but it was also entering into the foundries and working out problems in a practical way. They had a vast field in which to work. He did not think there was any field where there was so much scope as in that of cast iron. The properties of steel, bronze, and certain other metals were all well known, but cast iron was still very largely a problem, and its composition and properties made it one of the most difficult of problems. The Research Association, he believed, was going to lower cost and to increase profits. There were many new ideas being introduced in connection with the melting of iron. There was the idea, for instance, of the pre-heated blast, which was being boomed by the Germans. Then there was also the idea of having pearlitic iron to give good castings. It was believed in many quarters that the greatest strength was obtained when iron was in the pearlitic condition. He thought the research staff should tackle these and other questions. If they wished to be progressive foundrymen and up-to-date, they could not afford to be outside the Research Association. They had been favoured that day with an address by the Director of Research, and he thought the Association was extremely fortunate in having in that position a man of the calibre of Mr. Pearce. (Applause.)

MR. J. G. PEARCE, B.Sc., Director of the British Cast Iron Research Association, responded to the toast and thanked Mr. Cameron for his appreciative remarks, and the gathering for the cordial manner in which they had received the toast. It was, he said, very encouraging. He wished to emphasise the fact that the Association was intended to effect co-operation between the practical and the technical sides of the industry. He thought that in the cast-iron trade these two sides were more closely interwoven than in any industry in the country. Co-operation was essential between the man whose work was predominantly on the practical side and the man whose work was mainly in the laboratory. He looked forward to the time when the cast-iron trade would be regarded by every foundryman as a national institution.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Communism Amongst the Miners.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—May I invite the hospitality of your columns to bring to the notice of your readers the utter indifference of the miners towards the workers in other sections of industry. The agitation that is being so energetically pressed by the self-proclaimed Communist, Mr. A. J. Cook, secretary of the Miners' Federation, shows that he and his friends are determined to go to all lengths in the endeavour to force another advance in wages from the owners. Not content with the damage they have done to the coal industry by their last attack, they are now engaged in carrying still further the policy which Mr. Cook propounded in "The Miners' Next Step," which, some of your readers may recall, was to keep up a constant agitation for higher wages and shorter working hours until the whole of the owners' profits had been extracted. This, as a prelude to the "Nationalisation" of the entire industry. The lack of consideration for other trades dependent upon reasonably cheap coal for their existence has recently been demonstrated by Mr. McGurk, of the Lancashire Miners' Federation, who, in the "Manchester Evening News" of January 12, is reported to have advocated "a national demand that would bring wages equal to the cost of living, and if this were done the mine owner could charge more to those people who can afford to pay it. These people are the big industries in the country." Mr. McGurk further said that the "poor people are paying enough for their coal, and that the industries that are making the huge profits can afford to pay more."

Putting aside the fact that Mr. McGurk's "huge profits" exist only in his imagination, his concern for the "poor people" is strangely displayed. Even a miners' leader should know that you cannot raise the price of coal to our manufacturers without increasing the cost of the commodities they produce; and as our own people are our principal customers, Mr. McGurk's suggestion would result in the "poor people" having to pay more for everything they use, and would have their cost of living increased in order that more money might go into the miners' pockets.

The workers in the foundry trade should know that, whereas in 1913 the wages paid on each ton of commercially disposable coal were 6s. 10½d., the returns for the September quarter of 1924 showed that the amount similarly paid for that period was 13s. 8.19d., and their hours underground had been reduced from eight to seven.

I should like to know what workers in any of the competitive industries are receiving 100 per cent. more than their pre-war return for the same amount of work, together with a 12½ per cent. reduction in their hours of labour?

I dare not trespass further on your space, but if any of your readers would like to have some statistical information I shall be very pleased to forward it.—I am, Sir, yours, etc.,

A. E. RITCHIE,
Late Managing Director,
Snowdown Colliery,
Limited.

57, Clarence Gardens,
London, N.W.1.
January 21, 1925.

Gazette.

MESSRS. J. M. BROWN and J. PIMLEY, brassfounders, 44, St. Paul's Square, Birmingham, trading under the firm of Archer & Company, have dissolved partnership.

THE HYDRAULIC POWER AND SMELTING COMPANY, LIMITED, are being wound up voluntarily. Mr. E. V. Staff, 1, Regent Street, S.W.1, has been appointed liquidator.

Standardisation of Fans.—The necessity for fan standardisation was shown by Mr. Oswald Stott in a Paper on "Water Gauge," at the last meeting of the Institution of Heating and Ventilating Engineers in London. Mr. Stott referred to the Committee set up by the Institution to deal with the subject, and thought there was no reason why the difficulties should not be pointed out, together with the reasons, because they might be partially avoided—pending a common method being put forward by the Committee—by stating clearly what was desired when sending out an inquiry for a fan. Taking, for instance, a fan for induced draft in a range of boilers where the main flue to which the fan was connected was, usually, much larger than the fan inlet, so that the velocity was much less. The specified draft was invariably the one required in the main flue (where the velocity was much lower than through the fan inlet), so that it would not do to specify, say, 1½-in. w.g. "static" without saying that this draft was required in the main flue. Otherwise a fan would be put forward by some fan makers giving 1½-in. w.g. "static" at the fan inlet and the 1½-in. w.g. would then include the "velocity w.g." at the fan inlet, giving a much less draft in the main flue. In a ventilating plant which had a duct upon the inlet side it was advisable to state quite clearly whether the water gauge specified included that required to produce the velocity or whether it was the resistance only.

A Review of the Physical Properties Involved in a Study of Moulding and Foundry Sands.*

BY L. DELTOUR.

A technical examination of moulding sands suggests the study of an interesting and characteristic property possessed by few other bodies. With a certain proportion of water these sands are able to withstand extensive deformations without loss of cohesion or form when the pressure is removed. Moulding sands consist mainly of silica and, as a secondary constituent, a clayey substance, hydrated silicate of alumina. Although the outward characteristics of the plasticity of moulding sands are well known, they have not been scientifically defined or measured. The argillaceous content of a moulding sand does not, by any means, indicate its degree of plasticity; there are sands comparatively rich in argillaceous matter that are not so plastic as others in which the clay content is lower. Plasticity is not a simple physical property, but is really a complex characteristic which involves consideration of deformability, degree of cohesion, adhesive force and true plasticity in the limited sense of the word. In all comparative experiments with wet sand it is necessary that the prepared material should always be of the same consistency. This does not, by any means, imply that the same proportion of water must always be used, because the various sands have widely different absorbent powers which would result in great differences in consistency with the same water content; thus a weak sand will absorb much less water than will a strong sand.

A number of different theories have been put forward to account for plasticity. According to Aron, plasticity is due to the spherical form of the grains of sand enveloped in clay. The volume of the pores or cavities between the grains of sand after complete drying is found to average 35 per cent. of the volume of the sand, and this is the same proportion that the spaces between a mass of spheres in contact bear to the total volume occupied by the spheres. On this basis plasticity would be explained by the physical phenomenon of suspension; it would then be sufficient to consider a plastic material as a liquid in which the particles of sand and clay are in permanent suspension. In obedience to the law of gravitation, the small spheres would gradually arrange themselves until the material had settled down in two distinct layers. If, however, the film of water between the isolated spheres does not exceed a certain minimum, separation becomes impossible, and the friction between the spheres and the water prevents the adjustment by gravity. The spheres are exceedingly small, and have a specific gravity of about 2.3. If the particles are not spherical, canals, more or less attenuated, would form between them, and, in consequence, the equilibrium would be disturbed and the particles of sand and clay would settle.

Although a large number of sands were examined microscopically by the author, in none did he find the grains really spherical. It would seem, therefore, more logical to attribute plasticity to the porous and spongy nature of the grains of clay in the sand, which, under the action of an exterior force, undergo a sort of binding or felting. A plausible explanation of plasticity then would be that the excess of water not only saturates the capillary channels of the particles, in the manner of a sponge, but also envelops their surface. This film of water would relax the cohesion of the particles, and at the same time act as a lubricant, so permitting their mutual displacement. Although these remarks are based on microscopic examination and direct experiments only, they are in accord with work that has been done before.

Experimental Evidence.

An experiment which supports these contentions consists in mixing a mass of felspar with water in a rotating barrel. After a time an impalpable slime is formed, which possesses the property of plasticity. If, however, the same felspar is mixed in the dry state and water is then added, the material shows no sign of plasticity. An analysis of the water from the wet mix shows that a certain chemical action has taken place whereby amounts of alkalies, by no means negligible, have been dissolved. The same effect occurs on a large scale in the decomposition of rocks, and it appears that in moulding sand cavities are formed which give to the products of decomposition—and especially to the clayey matter—a porous structure and, in consequence, plasticity.

Finally, plasticity may be attributed to a lamellar structure of the grains of sand and clay which are interleaved with one another.

Importance of Friction.

If enough water is added, its molecules will penetrate between the layers, so permitting their displacement, and, owing to molecular attraction, to set themselves parallel with one another; this adjustment would clearly be facilitated by hand or mechanical kneading. A mathematical explanation has been suggested based on the assumption that when a body is deformed a certain friction is set up between the ultimate particles; this has been called "internal friction." During deformation sliding occurs, not only among those particles directly exposed to the external force, but also many others, which proves that the particles can transmit the force. Moulding sand is an example of a material the internal friction of which is much less than its cohesion.

Porosity of a moulding sand is the relation of the volume of voids to the apparent total volume; the voids include the volume occupied by the absorbed water and the free water, but exclude the combined water.

The permeability of a sand is its property for allowing the passage of fluids. It is necessary to make a distinction between the voids which are in free communication with each other—thus allowing the penetration by a gas or a liquid—and the isolated pockets or bubbles between which there is no communication; the latter voids reduce the density of a mass of sand, but have no effect on permeability.

Substances which contain more than 14 per cent. of combined water part with the excess of this water between 300 and 600 deg. C. Substances varying widely in plasticity harden round about 400 deg. C. before losing their combined water; when they have been previously dried they no longer collapse when placed in acidified or alkaline water.

Silica, which is the principal constituent of moulding sand, generally appears as quartz.

It is well to remember that under the influence of heat silica expands very irregularly. Up to a temperature of 600 deg. C. silica expands regularly, but above this temperature and up to 1,100 deg. C. the expansion is nil, if not even negative. This sudden expansion of quartz round about 600 deg. C. accounts for some of the troubles in a foundry owing to the effect of the enlarging grains on the binding material in which they are enveloped. Since, during casting, a temperature of more than 600 deg. C. is rapidly passed in the mould, it is obviously very difficult to ensure a uniform temperature through the walls of the mould. The sudden expansion of the quartz grains on the interior faces sets up severe local stresses, which may easily be sufficiently great to cause flaking of the surface layers. It must not be forgotten that prepared moulding sand contains only one part of new sand, the remainder being old sand, which has already undergone the temperature fluctuations due to casting. It is practically certain that in this used sand the quartz has been in part transformed into amorphous silica, that is, it has become vitreous. The co-efficient of expansion of this form of silica is small and regular. The presence of this substance tends to reduce the harmful effect of the excessive expansion of the new quartz. On the other hand, the presence of chalk in a new sand favours the transformation of quartz into another form of silica known as cristobalite; this material has an expansion even greater than that of quartz—there is a linear expansion of 1 per cent. at about 216 deg. C. and 1.537 per cent. at 1,000 deg. C. There is no doubt that this substance arising from the presence of chalk is responsible for a great deal of trouble.

* Abstract of a translation of a Paper presented to the Fourth Paris Foundry Congress on behalf of the Belgian Foundrymen's Association.

Some of the Factors which Influence the Strength of Cast Iron.*

By A. Campion, F.I.C., Glasgow.

Cast iron, the highly carburised product of the blast furnace—sometimes referred to as the crude product—the raw material of the ironfounder, is at once the most complex and the most interesting material to be found in the whole realm of metallurgy. Its very extensive use notwithstanding it remains almost the least explored and understood metal as regards its behaviour and properties under varying conditions. This is in a large measure due to the ease with which it can be melted and poured into moulds, and to the mistaken idea, which persists in some quarters even at the present time, that it is a metallic body after the style of zinc or copper.

It is quite common for cast iron to be regarded primarily as a simple alloy of iron and carbon, contaminated with certain other elements, and investigation has been mainly directed to ascertaining the effect of these bodies, which are often regarded as mere impurities, in modifying the properties of the basal iron carbon alloy.

Cast iron, however, is by no means a simple alloy whose properties are merely varied by the presence of impurities. It is a conglomerate not of simple alloys or solutions, but of free bodies, compounds, and mixtures of compounds whose composition or constitution is not always the same, and, further, the composition of the mixture is largely a function of temperature, and may show very great changes between the time of pouring into the mould and the attainment of atmospheric temperature.

To many the complexity of the subject, and the numerous factors which play a part in governing the properties, has proved a deterrent to more than casual investigation, but to those who have given serious attention to the physics and metallurgy of cast iron the difficulty and complexity of the problem has made it one of the most fascinating subjects of metallurgical research. Comparatively small proportions of elements may produce very great changes in the properties of the mass, much greater than might be expected from an inspection of an ordinary statement of chemical composition.

It may be stated that within very wide limits the character of a casting, particularly its solidity and freedom from defects and general appearance, is influenced in a minor degree by ultimate composition.

Influence of Existence and Distribution of Components.

The mode of existence and the manner in which the components are distributed has a greater influence upon the properties than the actual quantities of the elements present. This is due to two principal causes:—

I. A substance may separate and have an independent existence, and the effect produced will depend upon when the separation is effected, *i.e.*, before, during or after solidification. If separation occurs before solidification the substance has freedom to take a position in accordance with the relative specific gravity, if during solidification freedom is restricted there is no chance of complete elimination, and it will become entangled in meshes of the solidifying mass, or migrate in the direction of the still liquid portion. A substance which separates after complete solidification remains intimately associated with the mass, its ultimate distribution depends on the degree of liberty of the particles, and the degree of independent existence it attains will be to a large extent governed by its diffusibility.

II. The substance may remain in solution, and thus have a direct action on the metal, and so modify its properties, *i.e.*, its tenacity, hardness, etc. It may also alter the behaviour of other bodies present.

It has already been mentioned that the wide variation in behaviour and properties of cast iron is not sufficiently explained by an ordinary chemical analysis, and the reason is that an ultimate analysis is simply a statement of the proportions of the elements which it contains, and does not indicate how they exist in combination or solution or suspension. Probably carbon is the only one which exists in a free state, and even that is doubtful; it is therefore necessary to know the constitutional and structural analyses before the composition and properties can be collated.

Table I shows the three methods of stating the composition of the same iron.

TABLE I.—*Three Ways of Expressing the Composition of Cast Iron.*

Ultimate Analysis.		Proximate Analysis.		Structural Analysis.	
	Per cent.		Per cent.		Per cent.
Total carbon	3.144	Graphite	2.334	Pearlite	72.936
Graphite	2.334	Iron carbide	8.775	Phosphide eutectic	8.680
Combined carbon	0.810	Manganese carbide	0.342	Manganese sulphide	0.303
Silicon	1.840	Iron phosphide	5.572	Graphite	2.334
Sulphur	0.110	Iron silicide	5.520	Ferrite (by difference)	15.748
Phosphorus	0.868	Manganese sulphide	0.303		
Manganese	0.510	Iron (by difference)	69.154		

Non-existence of Mysteries.

It will be readily understood after inspection of these three methods of expressing chemical results why in so many cases an analysis fails to indicate the reason for the abnormal behaviour frequently encountered in cast iron. These abnormalities are often styled "mysteries," but for every phenomenon there is an explanation if only it can be found.

"Mysteries" only exist for those who do not wish to find an explanation. An investigation should be made of every case of unusual behaviour and of every waster casting, and every possible avenue should be actively and persistently explored until the reason has been found; there is no more fascinating and profitable field in metallurgical work than the investigation of failures and abnormal results; certainly they often present great difficulty and many perplexing problems arise, but each one that is solved adds to our store of knowledge.

Strength of Cast Iron.

Many of the difficulties in connection with the behaviour and properties of cast iron may be traced to an imperfect understanding of quite common terms, for instance the expression "The strength of cast iron" is frequently used in a somewhat loose manner and without due regard to what it really implies. Strength means, according to the dictionary, vigour or force; applied to metals it really indicates the power of resisting fracture by force; but force may be applied in a variety of ways, so that when the term strength is used it should denote the power of the material to resist fracture under the conditions to be imposed in practice. Thus a casting to be used in tension should be represented by tensile strength, or in other cases by impact or vibratory test. This is comparatively easy in the case of simple castings, but what represents the strength of a complicated casting? Is it its suitability as a whole for a particular duty or is it the strength of the metal from which it is cast? How can the strength of the casting as a whole be determined? If it is the metal of which it is composed what property is to be taken as the measure of strength? These are

* This Paper was presented on behalf of the Institute of British Foundrymen to the Association Technique de Fonderie as the International Exchange Paper.

questions which have to be faced, but they are not easily answered.

It is an unfortunate fact that the term strength conveys to many engineers and foundrymen nothing more than the results of tests made upon pieces of metal which may or may not represent the bulk, whilst some foundrymen judge a casting solely on its appearance, and resent the imposition of any form of test, but surely that is a position which cannot be justified.

It will thus be realised that the strength of castings depends on a great many factors and variations can seldom be ascribed to any one simple cause either of material or treatment.

There is for every quality or grade of iron a use to which it is best suited and a treatment for it that will give the best results. It is only from a knowledge of the behaviour of the metal and the influence of the constituents usually present, with the effects of different forms of treatment that such results can be produced.

Attention has already been directed to the importance of the constitution and structure of cast iron, and a prime factor in determining what this will be is *temperature*—initial, casting and freezing—together with the cooling velocity. The initial temperature, in conjunction with the presence of foreign elements, determines the constitution in the liquid condition. A substance cannot be considered apart from its effect upon others, and this applies not only to the iron but also to the other constituents. In general, the presence of a substance in solution depresses the freezing point of the liquid, and gives rise to a progressive solidification.

In the case of a complex body like cast iron a great many changes take place between the beginning of freezing and cooling to atmospheric temperature, and the sequence and nature of them depends upon the rate of cooling; if it be rapid, some constituents are denied the time necessary for their separation, so that a certain amount of overlapping occurs. In a single casting of intricate design different portions cool at different rates, and in consequence the constitution and structure vary in the different parts. A casting of unequal or complicated form may exhibit totally different physical and mechanical properties in adjacent portions. The unequal cooling also sets up internal strains, often of considerable magnitude, which reduce the strength of the material.

Fig. 1 illustrates a simple experiment to show the effect of strain on the metal of a plain bar.

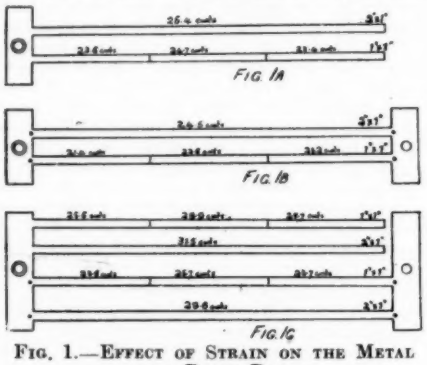


FIG. 1A

FIG. 1B

FIG. 1C

FIG. 1.—EFFECT OF STRAIN ON THE METAL OF A PLAIN BAR.

A and B were both cast at the same time from the same ladle, but in separate boxes. Each box contained a bar 2 in. × 1 in. × 42 in., and one 1 in. × 1 in. × 42 in. A was cast in the usual way, but B was cast so that the ends were held by iron bars driven into the floor.

C was cast all in one box, one bar of each size being free to contract naturally, and one of each size was held at the ends.

The 1 in. × 1 in. bars were each cut into three pieces, and each piece tested transversely at 12-in. centres. The 2 in. × 1 in. bars were tested at 36-in. centres.

It is to be noted that in all cases the bars which were free gave higher results for breaking load and deflection than those in which the full contraction was prevented.

Another interesting feature to which attention should be directed is that the centre of the 1 in. × 1 in. bars gave higher results than the end pieces.

Usefulness of Test Bars Limited.

This leads again to the question what represents the strength of a casting? If so great a difference is found in a simple bar, it appears probable that in a complicated casting the effects of unequal contraction and unequal cooling must be very large.

The question which next arises is what does a test bar represent? The stresses to which many castings are submitted in practice are exceedingly complex, and it is clear that no single test bar can give a measure of them, however the test is performed.

It comes to this, then. A test bar is useless as a criterion of strength of the casting, whether cast separately or attached to the casting.

All that a test bar indicates is that an iron cast into a particular size under certain conditions gives a certain transverse or other test result.

It is common knowledge that the composition may vary throughout a casting according to its thickness and rate of cooling, so that even if the furnace charge is correctly proportioned and properly melted, there may arise later other factors which will cause at least certain portions of the casting to be less good than desired.

Segregations and liquation, especially of phosphoric irons, play an important part in large castings, and there is also to be considered the alteration in physical condition of some of the constituents. The most important constitutional property of cast-iron alloys is the fact that carbon, the principal constituent, may exist in more than one form, and thus greatly modify the physical and mechanical properties of the material. The combined form confers strength, hardness, etc., on the mass, and the uncombined form gives weakness and flexibility. The relative proportions of the forms depend on chemical composition, casting conditions, temperature and rate of cooling.

Structurally, cast irons are conglomerates of essentially two very different parts, one free carbon or graphite, which is embedded in the second, which is a metallic matrix very like the structure of certain steels.

The main difference between various cast irons is the degree of weakening of the matrix by graphite; as the graphite increases in quantity or spreads into large flakes the weakening increases. A further difference between cast irons is the carbon content of the matrix. It might be anticipated that the greatest strength would obtain when the matrix contained about 0.90 per cent. carbon from the fact that the maximum strength of steel is obtained when the carbon is present to that amount, but it is found in actual practice that a smaller percentage of combined carbon gives the greatest strength. The reason is that with the higher carbon the cementite plates of the eutectic are so thick that if any one of them breaks it is likely to start a crack.

A casting of complicated shape or unequal section varies greatly in the matrix, and consequently a lower average combined carbon content of, say, 0.6 or 0.7 per cent. gives a stronger metal by the gain in strength due to the formation of smaller and finer pearlite, outweighing the loss that might be expected from making the matrix of lower carbon content.

Silicon ranks next to carbon in importance, not so much because of its direct action, but because of its influence on the solubility and stability of the cementite, the stability decreases and the graphite increases with increasing silicon.

The results of experiments by Andrew* seem to suggest that the stability of carbide is reduced by silicon even at quite low temperatures. It is practically certain that during the solidification of iron carbon alloys, in those of the hypo-eutectic type, after crystallisation of primary austenite, and in eutectic and hyper-eutectic alloys, the carbide first separates, and is then decomposed with the formation of graphite. Stead† and Andrew‡ have both arrived at the same conclusion, viz., that in some irons which become grey on cooling two independent cementites

* Carnegie Scholarship Memoirs, Vol. VII, 1916.
† British Association Reports, 1910.
‡ Carnegie Scholarship Memoirs, Vol. VII.

crystallise out, one a silico-carbide of iron and the other a carbide of iron; the former separates first, and as all silico-carbides are very unstable, they are the first to dissociate into silico-austenite and graphite. In irons which contain only very small proportions of phosphorus, two different cementites form, and crystallise together as a eutectic mixture. It is to be regretted that so far no method is known by which the two cementites can be isolated and their composition determined. If such were possible, it would doubtless shed considerable light upon the effect of graphitisation on the properties of cast iron. The notable greyness of commercial irons containing silicon is due to the ease with which these carbides decompose by the action of iron silicide.

The carbide of iron itself is not quite stable. Stead has shown that pure white iron containing no silicon will, on heating, contain some graphite, the amount of which may be increased by heating the iron in contact with silicide of iron. Gonterman* has confirmed the results of Stead, whilst Saniter† has shown that pure iron carbide is to some extent unstable.

The influence of silicon on iron carbide has been very fully investigated by Charpy and Grenet‡; and Hatfield,¶ as a result of an extensive series of experiments with irons containing sulphur and manganese, from which the carbides were separated and examined, came to the following conclusions:—(1) The silicon is not uniformly distributed; the carbide contains less silicon than the matrix, but that the amount bears some relationship to the total percentage. (2) Manganese is in combination with the carbide to the exclusion of silicon. (3) Irons containing much sulphur give carbide with low silicon, but no sulphur is found in the carbide, its action being obscure; and (4) In slowly-cooled irons practically the whole of the silicon is found in the carbide, and in quickly-cooled samples any silicon not in the carbide is found in the solution.

The author has obtained results similar to those of Hatfield, but in open grey siliceous irons there is nearly always silicon in the graphite. The action of silicon is to reduce the solvent power of iron for carbon, so that the eutectic alloy containing 4.3 per cent. carbon is greatly modified by gradual increments of silicon, as shown by Wüst and Peterson.**

The capacity of the iron for carbon is, as shown by Stead,†† to some extent affected by phosphorus, but it appears to be only to the extent to which iron is withdrawn to combine with the phosphorus.

Free carbon affects the properties of the iron not only in accordance with the amount present, but also according to its physical condition and the manner of its distribution. The carbide is separated during cooling, and is dissociated according to the amount of silicon which is present. In iron containing much silicon, the decomposition is virtually complete, and there is left a matrix of a solid solution of silicide of iron in iron, in which the graphitic plates are embedded.

The size of the graphite plates depends on the degree of diffusibility of the substances and their rate of dissociation. If the cooling be very slow, the period of free diffusion and concentration is prolonged, and this permits of the formation of large plates of cementite, which in turn produce large graphite plates. Uniformity of diffusion and dissociation is necessary to the formation of small and evenly distributed graphite particles, so as to ensure that there shall be the minimum interference with the strength and physical properties of the iron.

Influence of Casting Temperature.

The casting temperature plays an important part in securing this uniformity of diffusion and concentration, with the necessary fine-grained metal having strong intercrystalline cohesion. It is possible to obtain a close-grained metal from cool cast material, but the intercrystalline cohesion is weak and the strength of the iron is deficient, due to the fact that complete solubility had ceased to exist before pouring completed.

The ideal temperature for casting would be such that the mould could be completely filled, whilst all constituents of the iron are completely in solution, and that they should begin to separate immediately thereafter. This is an ideal not always easily obtainable, but the nearest possible approach to it should be attained. The gates and runners must be adjusted to obtain this; there is a best pouring velocity for every size and form of casting, and if this is arranged, then suitable cooling conditions result, with normal crystallisation prior to the saturation point of the carbide being reached. Objectional graphite growth is thus prevented, and a mechanically sound structure is obtained.

An example of such conditions is the phosphide meshwork arrangement to which Cook and Hailstone* have drawn attention, the strength of irons having that type of structure is not primarily due to the meshwork of phosphide eutectic, but to the fact that the arrangement results from suitable casting and cooling conditions, and that its presence is evidence of correct working.

Smalley† has directed attention to the importance of correct gating and proper running velocities. The effect of manganese is important. It balances and neutralises a certain proportion of the sulphur, and thus tends to greater fluidity and cleaner running, which, as has already been mentioned, tends to increased soundness and strength in the casting. Manganese also stabilises the carbide. The compounds of manganese are more stable under heat influences than the corresponding compounds of iron; manganese is therefore of importance in castings to be used under conditions of high temperature, such as for superheated steam or internal-combustion engine work. Some manganese may exist in solution in the silico-ferrite, and thus increase tensile strength and elasticity of the iron.

Manganese also counteracts to some extent the tendency of silicon to graphitisation, reduces growth, and increases resistance to wear. Irons containing manganese in quantity also machine with a fine, smooth surface. Excepting the reference to contraction stresses, the factors so far dealt with have all been intimately connected with the composition, constitution or structure of the metal, and its relation to the strength, but there are many other factors which have a profound effect upon the strength and allied properties of cast iron. It would unduly lengthen the Paper to consider them in detail, so that only a brief reference will be made to some of the most important.

The first requirement of a casting is that it should be perfectly sound, as no matter how good and strong the metal that may be put into a casting it will be useless if it is unsound. It is a regrettable fact that it is at present impossible to detect unsoundness until the casting is machined or tested under pressure unless the defect is very patent, excepting, of course, by the expensive and not yet practical application of X-rays.

Unsoundness may be due to a variety of causes, such as:—Unsuitable composition, casting too hot or too cold, unsuitable cooling conditions, errors in moulding and manipulations, occluded dirt, slag or gas.

The most usual errors of composition giving rise to unsoundness are excessive sulphur with a deficiency of silicon and/or manganese, causing the metal to have a high solidification temperature with a small range of fluidity and tendency to chill; such metal is liable to hinder the escape of gases before the viscocity of the metal becomes too great.

Casting temperatures and cooling conditions must be governed by the type of metal used and the complexity and size of the casting, so as to permit of the separation and disposition of the eutectic and the consequent strong intercrystalline cohesion and graphite deposition on the lines already laid down earlier in the present Paper.

The presence of dirt, slag and gases is responsible for more trouble and weakness in castings than is ordinarily realised.

No matter how much care is taken in mixing and melting metal or in the selection and preparation

* Jour. I. & S. Inst., 1911, No. 1.
† Jour. I. & S. Inst., 1897, No. 1.
‡ Engineering, 1902.
¶ Royal Society A., Vol. LXXV., 1911.
** Metallurgie, Vol. III., p. 811.
†† Jour. I. & S Inst., 1900, No. 2.

* Proc. Inst. Brit. Foundrymen, 1908-1909.
† F. T. J., Vol. XXVII, 1923.

XUM

of the sand and in making the mould, there is always a probability that some dirt may be carried into the mould:—(*a*) Through inefficient skimming; (*b*) patches of blacking or pieces of the mould cut away during casting; and (*c*) sand detached from the pouring basin, gates and runners.

Dirt carried in with the metal usually collects where the runner enters the mould, especially if there is change of direction or obstruction to the flow, and thus produces a dirty place in the casting.

Material detached from the mould will tend to float towards the top and lodge at the first point where the flow of metal meets with resistance. The dirty spots are seats of weakness and centres from which fracture may start.

Another very serious objection to the presence of such material is that the gases that may be liberated from the metal or that may be bubbling up through it attach themselves to the first solid

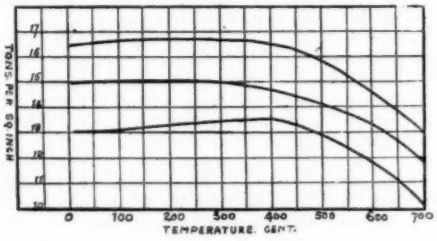


FIG. 2.—TENSILE STRENGTH OF CAST IRON AT VARIOUS TEMPERATURES AFTER ANNEALING.

material with which they come in contact, and it is not at all easy to dislodge them; other bubbles in turn attach themselves, especially in viscous fluids. The original small particle of dirt may become the centre of a relatively large area of unsoundness or the cause of a large blow-hole being formed. This principle applies generally with regard to gases liberated from or passing in bubbles through fluids, and applies equally to the retention of bubbles on the skin of iron that first forms, the rougher the surface the more readily the gases become attached, and owing to the tendency of the iron to crystallise the solidified surface of the metal on the interior is specially liable to be affected in this way. The gas bubbles usually follow the radiating crystal structure of the metal, and there are usually less of them at the bottom than the top of the casting. If the gas can be induced to rise to the top the castings will

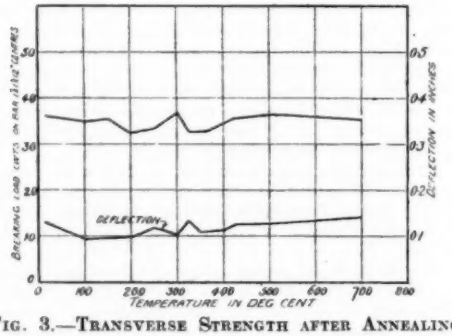


FIG. 3.—TRANSVERSE STRENGTH AFTER ANNEALING.

be clean and sound, and it is for this reason that head metal is cast on.

In many cases unsoundness is attributed to gases absorbed during melting and liberated during solidification, whereas the real cause is air which has been sucked into the mould with the metal on account of the use of unsuitable or badly placed gates and runners, or pouring from too great a height whereby the air is carried in by the falling metal after the manner of the Bunsen pump. The remedy in the former case is obvious, and in the latter a small trap or riser placed close to the gate is an effective preventive of air being carried into vital parts of the mould. The strength of cast iron is much influenced by heat or other treatment after solidification and cooling.

The question of heat treatment is much too large to be fully considered here, but the general effect of annealing on the tensile, transverse and impact values is indicated in Figs. 2, 3 and 4.

It will be observed that tensile strength falls rapidly if the iron be annealed at temperatures higher than 500 deg. C. The upper curve represents a metal containing more manganese than the lower, otherwise the compositions are practically identical.

Castings are often annealed to remove internal strain or to permit of machining more easily at higher speeds, consequently if loss of strength is to be avoided the temperature of treatment should be below 500 deg. C.

The change in the transverse strength brought about by annealing is indicated in Fig. 3, and beyond behaving rather erratically when treated at temperatures between 250 deg. C. and 350 deg. C., little change is observed up to 700 deg. C. either in strength or bending.

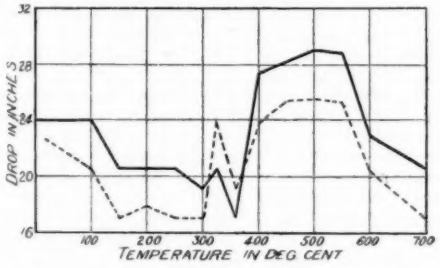


FIG. 4.—IMPACT STRENGTH AFTER ANNEALING.

The resistance to impact is shown in Fig. 4; it falls to about 250 deg. C. and rises from 350 deg. C. to 550 deg. C., when the maximum is reached, and at higher temperatures falls away rapidly. The full line curve is the higher manganese metal.

Fig. 5 shows the changes in tensile strength at various temperatures—that is the strength of the material whilst hot, and after being kept for one hour at the stated temperature.

The test bars were 1½ in. dia., and turned to 0.75 sq. in. area in the centre. The full lined curves represent the material tested in the untreated condition and the broken lined curve gives the results obtained on the material after annealing at 400 deg. C. for four hours, and allowing them to cool slowly to atmospheric temperature before heating again to the desired temperature for one hour and testing.

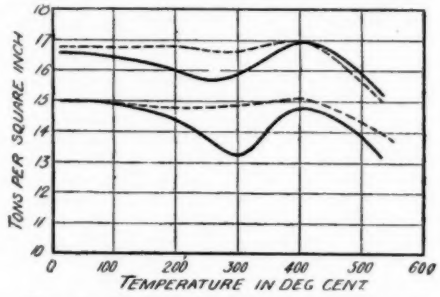


FIG. 5.—TENSILE STRENGTH AT INCREASING TEMPERATURES.

The time for which the material is maintained at the temperature before stressing has a very great influence on the result. The longer the heating the greater the reduction of strength. The question of changes in strength due to heating is one of profound importance to makers of internal combustion engines, and merits very careful and serious study.

MR. H. B. BARNARD has been taken into partnership by H. B. Barnard & Sons, metal, etc., merchants, 148½, Fenchurch Street, E.C.3.

A LARGE CASTING, 9 tons 11 cwts. in weight, 18 ft. in dia., was successfully transported from the works of Horsley Bros., ironfounders, Collingwood Street, North Shields, to Smith's Dock Company, Limited, North Shields. The casting was a propeller, made to the order of Baird Bros., North Shields, and is designed for the British tanker "British Earl," at present lying at Swan, Hunter & Wigham Richardson's yard, Wallsend.

Designing a 4-Ton Cupola.

By J. H. List.

Speaking generally, a cupola consists of a steel shell riveted together and fixed in a vertical position. In commencing to design the cupola the first thing to consider is what capacity will be required. Cupolas are known as ½, 1, 2, 3, 4, 5, 6 and so on tons per hour. The first figure required then is the diameter of the cupola, which will be capable of dealing with such an amount of iron.

The melting capacity of a cupola in tons per hour is equal to the product of air supplied in pounds per minute, multiplied by the square root of the pressure of air in ounces, and divided by 120. This, worked out, gives the following :—

Dia. of Cupola.		Max. Tons per Hour.
24	...	5.5
30	...	6.8
36	...	8.25
42	...	9.6
48	...	11.0
60	...	13.7

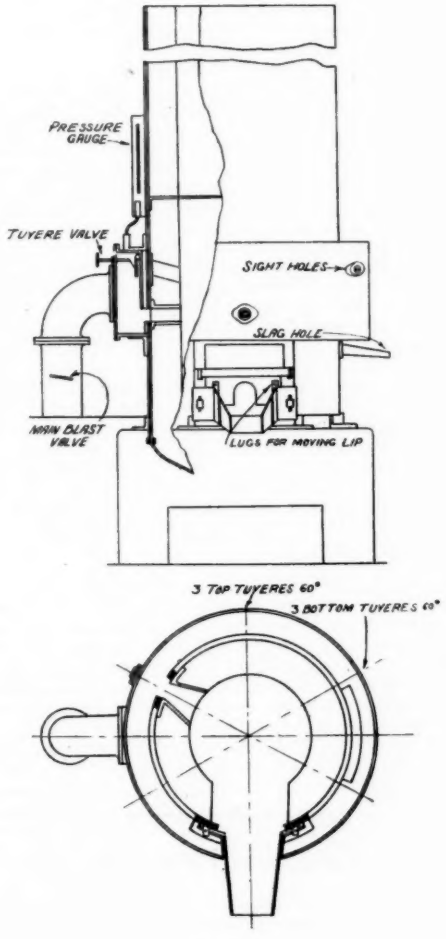


FIG. 1.

The above calculations are based on first-class fuel and laboratory conditions. For practical use it is not advisable to work a cupola to its full capacity, because of the effect which the heat and blast will have on the lining; so it is considered to be about 2½ tons less per hour.

For the purpose of this article a four tons per hour cupola will be taken as an example. This, then, will need a 30-in. dia. cupola. It should be pointed out, however, that this size will vary a little with almost every cupola maker, because they all have some special feature in their respective designs, and each claims to do more than his competitors.

After deciding upon the diameter, the next point is the height from the sole to the charging door. The ideal conditions would be to have it of such a height that the whole four tons could be charged on at once, so that the heat will be absorbed by the whole four tons before going to waste.

It must be borne in mind that some of the carbon dioxide formed takes up more carbon to form carbon monoxide, and, as heat is thus absorbed, any of the combustible carbon monoxide that escapes at the top, and burns in the air, represents so much loss of heat.

The height, however, is often governed by the buildings where the cupola is to be installed, and whether the cost of taking the iron, coke and flux up to such a height would be compensated by the heat thus saved. The usual practice is that the height is sacrificed. It would be an average practice to make a four-ton cupola about 12 or 15 ft. from sole to charge hole.

The next feature to be considered is whether the bottom of the cupola is to be of the "Drop" or "Solid" variety. After each blow the cupola contains slag and unburnt coke, which must be removed hot and in a fluid condition, or otherwise it will set. For this reason usually a drop bottom is provided which consists of a door cut in halves and hinged at the sides. When released at the centre will drop down, allowing the material left in the cupola to drop out. The only advantage such a design has, in the writer's opinion, is that the hot materials can drop into a slag wagon and be taken away to, say, the core ovens, where its heat may be utilised. The disadvantages are the risk of a run-out during the melting period—which would be serious—and it is apt to tear down the lining of the cupola whilst dropping the slag into the wagon.

In the case of the solid bottom the lip is taken off and the waste slag is raked out, and, when cold, the unburnt coke may be easily extracted and used again. The risk of a run-out is extremely small and the risk of damaging the lining is practically nil because the raking-out process is naturally slower.

For the purpose of this article, then a solid bottom has been selected.

The lip hole must be of ample size to freely admit a man without any trouble. It should be at least 18 in. wide and 15 in. high. At either side, and as shown in Fig. 1, there are provided two holdfasts with cotter pins fitted, these should be securely riveted to the side frame of the lip hole and be rigid as they have to withstand rough usage. The lip must project sufficiently to allow of the largest ladle required to go under, and still be able to be picked up by the overhead crane, or alternately for a bogey to run under. It is wise to have two carrying holes included so that it can be easily lifted on and off its position, as shown. The slag hole must be of ample size and so made that it can easily be "stopped off." The writer's experience is, however, that if the cupola is in the hands of a good man a slag hole is not essential.

Its disadvantage is that it is quite often left open during the whole heat, and this practice is very wasteful because it reduces the air pressure too much. The method recommended is get rid of the slag through the tap hole at intervals into a slag wagon.

A receiver is only necessary for big melts and on cupolas up to 4 tons it is an unnecessary item.

The object of the receiver is that it keeps the iron hotter than in the open ladle. For instance, if a casting takes 6 tons of iron and the cupola is only of 4-ton capacity, that means it will take 1½ hrs. to melt, and that if a ladle were used some of the iron would be in it at least ¾-hr. and would get very cold. In a receiver which has a hot blast passing over the top and is totally enclosed it would keep much hotter, but at a considerable cost.

The Tuyeres and Belt.

If only two tuyeres are being used, such as in small cupolas, the belt is unnecessary because the tuyeres can form part of the blast main. But if more than two tuyeres are used a belt is necessary to distribute the blast. In a 4-ton cupola the writer favours 6 tuyeres divided into two rows and each to have a sight glass and a valve to shut off the blast. With six it is possible to get quick melting or slow melting with ease, and this, particularly in jobbing shops, is a great asset, because the melting rate must be governed by the speed at which the iron can be used, and this varies considerably daily. The normal practice for a 4-ton cupola is to have the tuyere area about $\frac{1}{5}$ the area of the cupola at the melting zone. The cupola is actually 30 in. dia. at the melting zone, and the area is 707 sq. in. The bottom row is 2 ft. 3 in. from the bottom of the cupola. The tuyeres point straight in and are fan-tailed as shown in Fig. I. The top row of tuyeres is 12 in. higher and they point downwards at an angle of 70 deg. and are also fan-tailed.

All the tuyeres have an inlet hole of 6 in. wide by 3½ in. deep, their total area being 126 sq. in.

The sight holes are small, actually 1 in. dia., and are fixed as shown in Fig. 1. The tuyere valve is of a simple character, and is operated from above or near the belt. The blast-main valves are of the common flap type and are full bore when open.

The charge hole on a 4-ton cupola should be not less than 20 in. × 18 in., and no more than 2 ft. 3 in. from the stage floor if the cupola is hand fed.

Spark Arrester.

This part of a cupola which needs much, usually gets but little attention. On many cupolas is to be seen a cone-shaped hood acting as a spark arrester, which lasts but a little longer than it

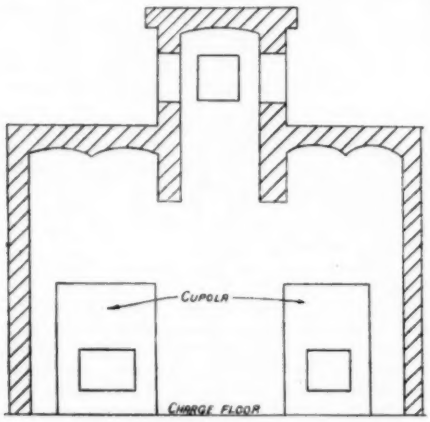


FIG. 2.

takes to erect. A design of an arrester is shown in Fig. 2, which has been in use 13 years without repairs. Without a good spark arrester the surrounding roofs, spoutings and drains will suffer badly.

The cupola lining should be made with a good quality fire brick. Near and opposite the charge hole the bricks should be interspersed with a few cast-iron bricks which will effectively protect the fire brick against breakage, caused by the impact of the iron thrown too far when charging. There must be at least ¾ to 1 in. space left between the fire brick lining and the outer shell of the cupola to allow for expansion. The thickness of the brick need not be more than 3 in. The lining should not be reduced in diameter near the melting zone; this form of lining only tends to form "arch-overs" during melting.

The volume of blast necessary for a 4-ton cupola has been found to be 3,427 cub. ft. of air per min. This figure is arrived at as follows:—Though the amount of air at 0 deg. C necessary to burn 1 lb. of coke to CO_2 is 129 cub. ft. The writer, however, considers that 135 is the lowest figure that should be calculated upon. The amount of coke required to melt a ton of iron varies considerably and is dependent partly on the quality of coke and partly on the method used, but from many years practice the writer counts upon 3½ cwt. of coke to the ton.

This is ratio of 5¾ to 1; this will give 135 divided by 5.7=23 cub. ft. of air required to melt 1 lb. of iron or 23 × 2,240=51,520 cub. ft. of air required to melt 1 ton. This gives for a 4-ton cupola 3,427 cub. ft. of air required per minute. The pressure necessary to melt 4 tons in this cupola has been found to be 14 oz.

With a constant volume such as that given by a Roots Blower, it is possible with such a pressure gauge, as shown in Fig. 2 to tabulate from actual practice, that with a given pressure which can be obtained easily by adjusting the blast main valve, any rate of melting can be obtained below the maximum at will. Although, of course, not so economically as when working to its full capacity, but, as stated previously, one must melt at the rate it can be taken away only.

Shop Trials of Diesel Engine at Wallsend Works.

The shop trials of one of the largest single-acting Diesel engines built by the North-Eastern Marine Engineering Company, Limited, are at present in operation at the Company's Wallsend Works.

The engine, which is built to the order of the Lancashire Shipping Company, Limited (managers—James Chambers & Company, Liverpool), will be installed in the motor ship "Raby Castle," 8,000 tons, built by Messrs. Caledon Shipbuilding Company. It is of the well-known Werkspoor four-cycle type, has eight cylinders, 730 mm. dia., by 1,300 mm. stroke, and is capable of developing 3,000 i.h.p. at 92 r.p.m.

The main frames are of the "A" types, and the through bolt, securing the frames and cylinder beam to bedplate, are of substantial cross section. The pistons and cylinders are water-cooled by means of a motor-driven circulating water pump.

The main air compressor is driven from the engine crank shaft (forward end) and, at the same end, there is also a pump (plunger type) for bilge and ballast duty. For test purposes the crank shaft is coupled up to a water brake.

The most striking feature of the present trials would seem to be the absence of vibration. When one stands on the top platform it is difficult to realise that the engine is working, although it is mounted on stools and is of considerable height.

The auxiliaries throughout the ship will be electrically-driven, and for this purpose there are three auxiliary Diesel engines. Two of these auxiliaries have each three cylinders, one end of the shaft being coupled up to a dynamo and the other end to an auxiliary compressor for charging air receivers for starting purposes. The third auxiliary engine has two cylinders, and is also coupled up to a dynamo.

The trials will be continued for a few more days, after which the firm hopes to make further reference to results.

Catalogue Received.

"Non-Ferrous Metals."—We have received from Kynoch Limited and the King's Norton Metal Company (Constituent Companies of Nobel Industries, Limited), a copy of "The Witton Book of Non-Ferrous Metals and Alloys." Whilst dealing very briefly with the historical and manufacturing side of the subject, the question of quality, testing and specifications is dealt with at some length. In short, this book should help considerably to bring manufacturer and user closer together so that each may profit from the experience of the other.

At the end there are a number of useful tables dealing with the weights of various non-ferrous metals in the different forms of strip, sheet, wire, rod and circles.

We understand a copy of this book may be obtained from the publishers, Kynoch, Limited, Witton, Birmingham, by mentioning this paper.

Selling Castings.—VII.

BY VOYAGEUR.

The salesman of castings must, if he is to succeed, have certain important qualifications, and it can be said that in no small measure the success of the foundry from the marketing point of view will depend upon his efforts. Whereas an ordinary traveller handling such general commodities as soap and silks can very quickly pick up the amount of inside knowledge necessary for him to have, the salesman of castings must be something of an engineer. To be possessed of sufficient engineering knowledge to be able to discuss castings competently with an important buyer means that a man must have had more than a general training in the requisites of salesmanship. That is why the best foundry salesmen are men who have begun in the drawing-offices and works offices of the firms they serve.

It must also be borne in mind that the salesman of castings does not win orders by eloquence, but by logical argument and detailed facts. One cannot descant upon the perfect appearance, the beauty of form, the æsthetic attractiveness of hydraulic cylinders or road wheels. The only thing that will impress the buyer is a ready grasp of his problem, and a lucid and accurate exposition of how castings may be applied to his own particular requirements. It is for this reason that whereas the salesman of castings might quite readily turn to selling soap or candles, the salesman of soap or candles could not so readily turn to selling the products of the foundry.

The foundry salesman must be prepared to answer with complete certainty queries of no little technical importance. Will castings of this material bear a tensile stress of so many tons per square inch? Will they resist bending under certain conditions? Why did another kind of material fail when used in a certain way? What permeability curves does his material give? And so forth. Of course, however well-trained in foundry work a salesman may be, he will from time to time encounter questions that he cannot answer, and may have to refer them to the works; but the point is that unless he can persuade the buyer that—without being an expert perhaps, he yet knows what he is talking about, and is not repeating like a parrot ready-made stock phrases—he will not get very far.

Furthermore, the salesman of castings must be able in an emergency to run a test, where the character of the casting renders it desirable, and to investigate complaints, should any arise. This will give some idea of his responsibilities.

It will now be as well to run briefly through a number of typical arguments with which the salesman's endeavours to secure orders will be met by buyers. The first and most frequent is this: "John Smith's castings give me satisfaction. Why should I change?" The reply is not to criticise Smith's castings, which is a course harmful more to one's own reputation than to that of the competitor; but to deal generously with Smith, as quite a good supplier, and then to pass on to a convincing discussion of the merits of one's own products. Thus it should be pointed out by the salesman that firms who have grown accustomed to receiving orders from a certain firm, often tend to become negligent or careless in course of time, and make mistakes or give bad deliveries; and that if such an eventuality should unfortunately arise, his firm would be glad of an opportunity to execute a trial order. Then the salesman should, using tact and discretion, make sure that the buyer does not feel so confident about Smith's satisfactoriness after his departure as before. He can, without once mentioning Smith, mention such things as the deliveries his own firm can make, the tests his castings will give, the quality of material and workmanship, the plant available for turning out a certain class of casting rapidly, etc. It is probable that among these details will be found something in which Smith is inferior, and though the buyer may not outwardly confess this, the seed of doubt will have been sown in his mind, and an inquiry may some day arrive as a result.

The next argument is: "All my inquiries go to a limited number of equally good firms, including yours. Quality being, therefore, equal in each case, I give my order to the firm quoting the lowest price."

The salesman must counter this by pointing out that there is no such thing as a number of equally good firms. The experience of one in a certain direction may be better; for example, one foundry may have been producing castings by the electric furnace process for seventeen years, whereas the other has only just begun. One may have a foundry equipped with more modern plant than the other. Another may get its raw materials from a better source. A fourth may have an altogether superior production staff. The salesman should concentrate on those points in which his own foundry excels, and emphasise them. He should point out that many foundries are specially cut out for the rapid and competent execution of a special type of casting; *i.e.*, one foundry may concentrate on colliery castings, another on locomotive castings, and so forth.

A third argument is: Stop visiting me. If I want castings from your firm I will write and tell them so.

Usually a reception of this kind means that the traveller has been badgering the buyer too much with mere formal calls to see if any orders are going. The only way in which these things can be avoided is by making no calls without a really sound excuse, and that excuse the performing of service. Thus, if a new foundry catalogue is published, the buyer might be glad to receive a copy, and the salesman could call and leave it. If a house-organ is inaugurated, a call might be made to ascertain whether the buyer would like to receive copies regularly. A calendar is another good excuse for calling. Some salesmen also make a practice of jotting down little bits of information concerning raw materials and so forth of value to particular buyers, and calling, seemingly benevolently, to give these. One salesman secured a large order for castings by passing on the information about an exceptionally cheap job lot of timber to a buyer whom he knew. The point is that if a buyer knows a salesman's calls have some point about them, and some value to himself, he will never rudely reject them.

The sales manager should bear in mind that he must help the salesman all he can to get orders. This is not done simply by writing encouraging or stern letters. There are a number of practical things that he can do; for instance, the salesman should be notified of any and every change in selling policy. There should be frequent and regular discussion of selling problems between manager and men. The advertising manager should exhibit his plan of campaign to the travellers and invite their criticism. Another good plan is to get a clerk to go through the "Contracts received" columns of the engineering journals and notify the salesmen of large orders placed with potential customers in their districts. This enables them to follow the trail of business, and to be first in the field when orders are given out as a result of the placing of these contracts.

Pulls of every new advertisement should be sent to each salesman, so that he may see what is being said about his goods, and may have his memory refreshed concerning the various talking-points. Copies of competing advertisements are also useful, because they enable the travellers to prepare in advance the arguments with which they may meet any reference to them.

If valuable testimonials are received from firms of repute, copies of these should be circulated to the salesmen, and will invariably be welcomed. The foundry should let the salesman know any new facts about the composition or production of the castings, and should support him in his work by giving good deliveries whenever he writes pressing for them. Similarly, the salesmen should co-operate with the sales department by passing on all the information of value from a marketing point of view that their travels bring them.

THE DEBENTURE HOLDERS and shareholders of the Newcastle Iron and Steel Corporation (S.A.) have ratified the sale of the undertaking to the Union Steel Corporation for £41,500 in cash and 87,300 shares. Negotiations are practically complete for raising £300,000 debentures to provide the capital necessary to develop the Newcastle Vereeniging Works.

A New Method of Measuring the Hardness of Moulds.*

BY E. RONCERAY, Paris, France.

This apparatus is based on the principle of Brinell ball hardness tester. It is composed (Fig. 1) of a small cylindrical brass piece (A) bored to a dia. of 15 mms. terminated by a flange (B), 25 mms. dia. At the end of the hole is a bevel circular stop (C) to retain the ball inside the tube, though allowing it to project outside of it. The ball is pushed out by a spring (D), the pressure of which is adjusted through a screw (E) screwed on the brass piece so as to give a pressure of one kilogram on the ball. A lock nut (F) is provided to avoid unexpected disadjustment. The pressure is measured by pressing with the apparatus on a scale or a similar process.

By placing the apparatus on a mould and applying sufficient pressure to bring the flange in contact with the sand of a rammed mould, the ball is pressed on this surface by the spring with a force of one kilogram and the diameter of the ball print varies according to the density or hardness of sand. To make the reading easier, it is advisable to spread french chalk on the mould and to blow it off when pressure has been applied. The chalk is pressed on the sand by the ball and the flange with the result that, after using a blower, a white circle appears surrounded by a white ring. A large number of readings can be made very quickly by this method which constitutes a rapid means of exploring the various hardnesses of a rammed mould.

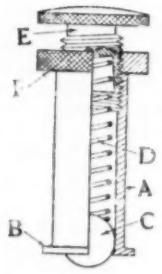


FIG. 1.

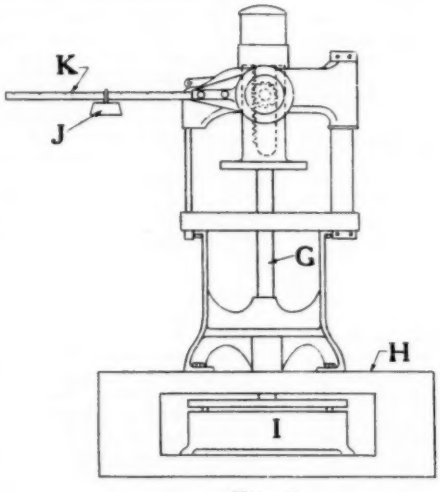


FIG. 2.

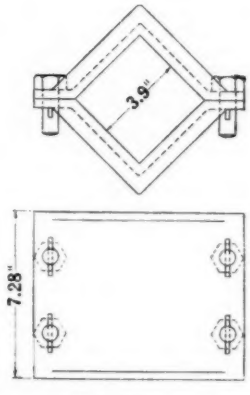


FIG. 3.

To determine the size of prints corresponding to different densities of sand experiments have been made with a small hand ramming machine of the type shown by Fig. 2. The ramming is obtained simply by a pinion and rack motion, the pinion having a lever bolted to it. To gauge the machine, the pattern drawing mechanism was taken out and replaced by a plunger which transmitted the energy of the ramming plate. The machine was fixed on timbers (H) bolted to a solid ground and a scale (I) placed below on which the end of the rod rested. Weights (J) were placed on the lever (K) at different positions so as to obtain total pressures on the scale of 100, 150, 200, 300, 400, 500, 600 and 700 kilograms. The positions and values of such weights were marked so that by simply repeating them, a known pressure was exerted on the ramming plate.

A flask 100 mms. square was selected for the experiments. This flask is shown by FIG. 3. It is split diagonally and both halves are joined by eyebolts and cotters. When the sand has been rammed, the flask can be opened and the cake of sand explored on the sides as well as on top and bottom.

The size of flask being 10×10 cms., the surface is 100 sq. cms., so that when pressures of 100, 150, 200, 300, 400, 500, 600 or 700 kilograms are applied on this flask the pressure on the sand is 1, $1\frac{1}{2}$, 2, 3, 4, 5, 6 or 7 kilograms per sq. cm. (15 to 100 lb. per sq. in.).

To get a fair knowledge of what happens under different conditions, experiments have been made with different degrees of moisture from 4 to 8 per cent. and various thicknesses from 25 to 100 mms. after ramming. Four per cent. moisture has been found to correspond to very dry sand and 8 per cent. to very moist.

Experiments are in progress to study by the use of the apparatus described various systems of ramming: Squeezing by ordinary methods, squeezing with a down sand frame, jolt ramming, hand ramming, pneumatic rammer ramming, etc.

These experiments are not yet sufficiently advanced to justify a complete discussion here, but it will be interesting to examine what is the relation between the unit pressure on sand and size of ball print and what is the influence of different degrees of moisture between practical limits mentioned above.

With the ordinary form of sand frame placed on the top of box, it is known that the sand is harder at the top than at the bottom. Fancy curves have been printed in this respect. If the edges are not taken into account, the *diameters of prints have been found independent of sand thicknesses* within the limits of experiments. Between top and bottom, the differences of pressure corresponding to ball prints average are rather small and comprise between 3.70 and 7 per cent.

A magnifying glass or a small microscope is convenient for measuring the size of prints.

This very simple apparatus can be handled by anybody and be used constantly in the foundry with a little experience. It is hardly necessary to measure the prints. The naked eye is almost sufficient to detect the weak points of wrong ramming.

* An extract of a Paper presented to the American Foundrymen's Association. The author is managing director of Messrs. Bouvillain & Ronceray, iron founders, Choisy le Roi, near Paris.

THE iron trade of South Staffordshire will sustain another serious loss by the announcement made recently that George Adams & Sons, Limited, of the Mars Iron Works, Wolverhampton, and the Cleveland Iron Works, Horseley Fields, Wolverhampton, have decided to close down and go out of business, in consequence of the unsatisfactory trading conditions now prevailing and the continued depression. The firm was founded in 1867 by Mr. George Adams, of Wolverhampton. Mr. Adams had two partners, but the partnership was dissolved in 1874, and for five years Mr. Adams continued trading alone. He was then joined in partnership by his three sons—the late Mr. George North Adams, Mr. Tom B. Adams, and Mr. John Adams. In 1894, soon after the death of the founder, the firm was converted into a private limited company.

Foundry Work and the Draughtsman.*

By A. Sutcliffe, M.I.Brit.F.

In considering this subject it is found that the average draughtsman takes such a small amount of interest in the foundry work that it becomes necessary to consider the point of view that a draughtsman should take rather than the one he does.

Quite a number of draughtsman do not consider the foundry at all, or perhaps only when a bad casting has been turned out, and then their consideration is only for the purpose of recrimination.

From the remarks which are sometimes made, one is induced to conclude that a casting with a high finish and correct to one-hundredth of an inch is the ideal thing from the drawing-office point of view. This, of course, is quite impossible in practice; what should be demanded is a clean, sound casting, correctly shaped and within reasonable limits of the drawing size. It is impossible closely to define "reasonable limits," as each job must be judged on its own merits.

Taking foundrymen generally, only a small proportion can claim to be able to read with moderate

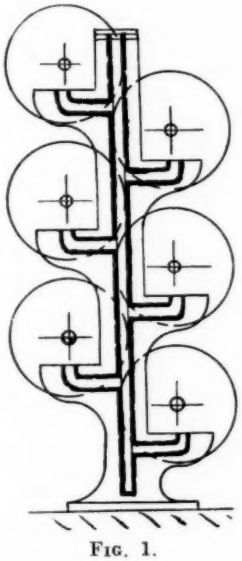


FIG. 1.

understanding a correct drawing from the drawing office; and while it is admittedly not part of the usual foundry instruction to study drawings and their meanings, it is also admittedly a great advantage to the foundryman to be able to understand, if not to execute, the draughtsman's work.

In the endeavour to cut down pattern-shop and foundry expenses, many people overlook the essentials of the matter, and particularly the faults that arise in the drawing office. The lack of foundry knowledge on the part of the average draughtsman is really immense.

It has been many times proved that a draughtsman who has had a good machine-shop and fitting-shop experience is the man who makes the least errors in drawing, from the point of view of machining; as a natural result it has become quite usual for a head draughtsman to insist on his assistants having a shop training. In no sense of the word does this apply to the foundry practice, but why such an important branch should be overlooked is difficult to say; still the fact remains, and until it is altered bad castings will also remain.

The remedy is as clear as that for overcoming machine and fitting-shop troubles, so why not apply the same treatment in the case of the foundry?

In the drawing office large alterations can be made by simply altering a line or so and at the cost of minutes only, but the case is very different when the pattern, and perhaps the casting too, have been made; alterations then become a matter of days and perhaps weeks, in addition to the waste of time and material.

It is somewhat curious that, when it is contemplated sending a young man through the shops, the foundry is generally omitted, although this is really the place from where he should start. There is no need for him actually to work as a moulder, but he should certainly know how the different classes of patterns are taken from the mould, how the metal is poured, and how it flows under various circumstances so that a sound casting can be obtained. When he has acquired some knowledge of these matters, even if only very slight, he will be much better able to follow the practice of the pattern shop, he will also understand why patterns are constructed by certain methods, and this knowledge should be of service to him later on. Many draughtsmen only obtain

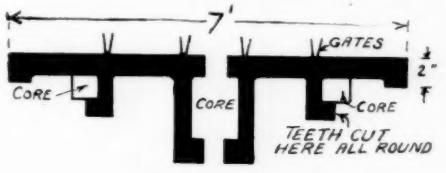


FIG. 2.

their experience from other draughtsmen, and not directly from the practical source, namely the shops.

It has been said by a chief draughtsman who, when looking at an old drawing made by a man a few years ago, remarked, "We shall have to wait until the trumpet blows before we can understand this drawing." Here the drawing office may fairly come under criticism, for a very large number of drawings that are produced from important offices are not good—indeed, they are distinctly bad—in that they are both inaccurate and hardly intelligible even to an experienced man, leaving out of consideration an ordinary moulder or patternmaker.

To return to the foundry and pattern shop, it is not practical to make all patterns of a uniform thickness throughout, and consequently the

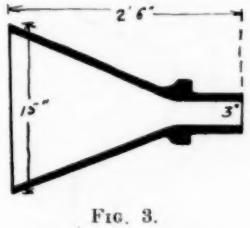


FIG. 3.

moulder must so apply his knowledge in the making of such castings so that they will behave like regular and uniform castings. To do this, he must remember the properties of cast iron, the putting of the gates, the ironing of the mould, and the bearing of the casting when cast. A casting of uniform thickness and structure will contract towards its one centre, but a casting that is not uniform will have more than one centre of contraction, therefore each part of the casting having its separate centre of contraction will be drawing away from another part.

These facts are almost sufficient to condemn such section as impractical if such were the only action of the metal; but there is another point which must not be overlooked, that is, that metals generally are good conductors of heat, and therefore it may be expected that one part of a casting will conduct its heat to another part and so keep a more uniform temperature throughout the whole casting.

One of the greatest troubles of the moulder appears to be that of the unequal thickness of

* A Paper read before the Burnley Section of the Institute of British Foundrymen.

castings as designed by the draughtsman; and it is a trouble which is ever present, and has continually to be reckoned with.

It is necessary with nearly every job to find some means of counteracting the "drawing" of the thick parts, for not only do the drawn holes in the thick parts look unsatisfactory, but a steam pipe, cylinder, or any other casting that has to withstand a test invariably leaks through the thick part on account of the metal being more open in that place, unless closed by some means.

There are many ways in which this drawing may be counteracted and the grain of metal closed. The use of chills will often serve, or possibly only a nail or two may be required to hold up and close the metal in a boss or lug. The draughtsman may be approached, and perhaps it will be found that he may be able to alter the design and place a core in the thick part, or otherwise

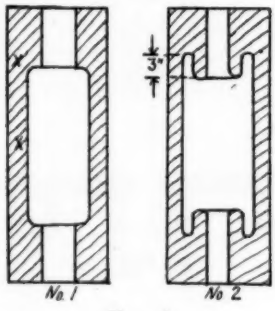


FIG. 4.

reduce the quantity of metal so that the thickness is more uniform throughout.

Often a core is left out by the pattern-maker because he thinks it will be difficult to get into its place, but it does not occur to him that in so doing he is causing trouble for the moulder.

The author well remembers a pattern of a drying machine side, with all the branches on for the doll heads, being sent into the foundry as a 2-off job. The master of this firm was a draughtsman but not a moulder. The result was that this job, 18 ft. long, was never a good casting, so was afterwards made in 9-ft. lengths. Many more

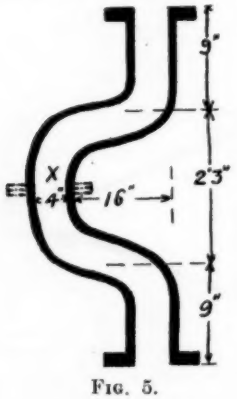


FIG. 5.

similar incidents could be called to mind which have happened during the author's life in the foundry, which is now 34 years.

Chills.

There are two kinds of chills; the first is all iron, or an iron core such as is made for face plates to core out centre bosses. These are cored out by means of a chill, when a thread cut has to be cut. The second is a densener, which is only a part iron-core, such as pieces of iron bedded on cores, or the pattern or mould, to solidify the metal. The author has seen as many as 1,300 denseners on one core for a gas-engine cylinder. Chills were first brought out by Germany. But since then a man named Sam Welden patented the Densener in Manchester about 20 years ago.

When chilling any casting that has to be machined, the foreman should see that there is sufficient metal round the chill or it will be too keen, and the casting will turn out faulty when machining. The conditions are only controlled by experience. But if a chill is being made in which to cast a casting, the iron mould would be made four times the weight of the casting required.

A number of examples are submitted as illustrating the necessity for a clear understanding of foundry matters by the designer.

Drying Machine Side.

This is illustrated as in Fig. 1. It was originally 18 ft. long, but as such was never a good casting. Afterwards it was made in 9-ft. lengths. There is a 1½-in. elbow core in each bracket, which in addition to the excessive length, was also a cause of much trouble. The mould did not blow for an appreciable time after casting. The owner of the foundry was primarily a draughtsman, and not a moulder.

Strap Pulleys.

This individual was also responsible for an order given that all pulley pattern rims had to be ¼ in. thick to economise both metal and machining. The result was numerous imperfect castings were made and the turner was ruining the

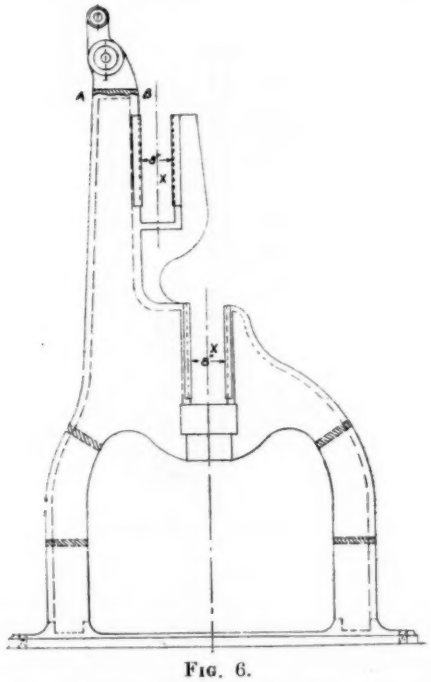


FIG. 6.

edges of his turning tools by endeavouring to machine sand. For a crowned and many other types of pulleys it is necessary to lag up either inside or outside with wood strips. Various sizes of bosses are put on these pulleys by draughtsmen who never consider either the contraction or that it has a chambered core.

Machine Tables.

The moulding of a wheel table 7 ft. diameter, which weighs 25 cwt. and 1¼ in. thick, with only 3-16 in. machining allowance on the face presents some difficulty, as it is moulded face side up. With such a small allowance it is difficult to avoid troubles associated with gas, sulphur and blowholes. The job is illustrated in Fig. 2.

Tundish Casting.

Fig. 3 represents a sketch sent from the drawing office to the pattern shop, where a pattern was prepared from a short length of 4-in. pipe pattern lugged up size and shape. The pattern-maker also provided a core board from which to form the core. The casting was found to be twice as heavy as it was intended to be, undoubtedly a mistake due to the makeshift character of the pattern. If the foreman moulder had been consulted, he would have contented himself with a core-board and put on to it the necessary thick-

ness for half an inch of metal. This would have been cheaper and more reliable.

Hollow Cylinders.

Castings similar to Fig. 4, though both performing the same function, type 2, necessitates a good deal more core-making. The board has to carry a loose piece, whilst there is considerable difficulty in venting the enclosed portions through the core barrel. The author has only had one of type 1 crack in the course of a long experience on castings weighing but a few pounds up to five tons. The one which did crack went at X, and not at X^1, as might have been expected. The metal was 2½ in. thick. It would be interesting to learn the reason for design 2.

A Lead Pipe Casting.

The bent lead pipe illustrated in Fig. 5 presents features of interest. If it had been required to be made in iron no serious difficulty would be present, but in lead the extraction of the core and core irons, often of ⅜ in dia., is likely to spoil the shape of the casting. The author, therefore, made two holes, facing and centrally situated, through which he was enabled to cut the core iron. The bore was then filled with sand, and more metal burned on the holes. Whilst this helped the draughtsman over his difficulty, it is suggested the design would be equally as good if it was cut into two parts and flanges added, as shown in dotted outline.

Mangle Cheek.

The mangle cheek casting, Fig. 6, is preferably cored out at X, as it has loose pieces and the pattern is left to be moulded in green sand. This method will add about a moulder-hour for each casting, but its advantages warrant it. On one occasion the draughtsman made the casting 10 in. too long. Only one casting had been made and it was remedied in the foundry by cutting off a 10-in. piece about the line A—B and welding the two pieces by "burning-on." One being moulded was made good, using a piece of pattern and stopping-off.

Conclusion.

Sufficient examples have been given clearly to illustrate that it is essential that he should co-operate with patternmaker and moulder. He would undoubtedly benefit by associating himself with their national technical organisation.

DISCUSSION.

MR. PELL said he agreed that sometimes the drawing office were to blame, but he did not think that was so in every instance put forward by Mr. Sutcliffe. For instance, the lead pipe (Fig. 5). No doubt instructions were given to the draughtsman to design a pipe of the required dimensions, and he carried out his instructions, leaving it to the foundry foreman and the patternmaker to settle between them how the job should be done. The foundry foreman would be supposed to know his business, and to have had experience of jobbing work which would enable him to understand the correct way of proceeding.

MR. SUTCLIFFE, interposing, insisted that the object of the Paper was to bring out the necessity for co-operation between the drawing office, the pattern shop and the foundry.

MR. PELL agreed, but pointed out that in this case the drawing office cannot be justly blamed.

MR. HOGG asked whether Mr. Sutcliffe had any trouble with central chilling. Suppose in a mass of metal, 12 in. deep, 12 in. diameter, with a 2-in. hole in the centre, unless it was cast with a low-silicon iron, associated with a high combined carbon content, one would use a densener, but his experience of using denseners was they acted as conductors of heat, and they were much better when there was a lateral surface attached to the outside packing sand. If they were in a block, such as Mr. Sutcliffe had just shown, and it was only 2-in. diameter or 2-in. face, and touching the packing sand, they lost efficiency and sometimes made the evil worse instead of remedying it. Instead of conducting the heat away rapidly, which a densener should do, they became heated up and they held the heat. The best form of densener was one which would conduct heat rapidly away from a large surface to the outside packing sand.

Referring to the drying machine side (Fig. 1), Mr. Sutcliffe remarked that the use of oil sand cores would make a considerable difference in this job, but when he had to deal with the problem twelve years ago the only solution was to cut it into two lengths, each of 9 ft. Before they started to make it, they expressed the opinion that it was too long, but they had to try it.

MR. PELL said oil-sand cores had been in use more than twelve years. Linseed oil had been used with river sand and sea sand for a much longer time. It was quite possible to make this job satisfactorily twelve years ago if proper material was used to make the core and the core had been brought out right.

MR. SUTCLIFFE replied that he was convinced if Mr. Pell had had to do it under the same conditions he would not have done it differently. The elbow cores were made with ordinary core sand, a good bond through.

MR. PELL suggested that the lead pipe (Fig. 5) could have been run in two places.

MR. SUTCLIFFE said he ran it from the centre. They had three or four trials. The first two were apparently good castings, but they did not stand up to test. Success was achieved by making in two halves.

MR. HOGG said the pipe (Fig. 5) was well known to him, and it was certainly a difficult job to cast. It would have helped considerably to run in two places. A very good vent was essential, and it must not be run too fast, otherwise the air had not time to get away; it became choked and began to blow. He had seen piled up in a foundry yard as many as 16 which had been scrapped.

MR. VERNON remarked that he did not wish to criticise Mr. Sutcliffe, with whom indeed he was very much in agreement on the question which was raised by this Paper. Sometimes the drawings were wrong, after they had passed through the patternmaker's hands, into the foundry, where the mistake was discovered.

MR. HOGG, in proposing a vote of thanks to Mr. Sutcliffe, said, on the main point, the necessity for co-operation, they were all in agreement. The three departments—the drawing office, the pattern shop, and the foundry—were working for the same object, and if any one section failed to co-operate much unnecessary trouble would arise. If alterations had to be made in the foundry the draughtsman would come down and alter his drawing, but if such occasions were numerous an explanation would be called for. So the idea of co-operating was an excellent object for foundrymen to work upon, and, if carried out properly, it would simplify their work, reduce cost, and benefit both the firm and the industry.

MR. TAITE seconded the vote of thanks. It was supported by Mr. Pell and Mr. Hilton, and passed unanimously.

In replying, MR. SUTCLIFFE said it might be thought that he had been severe in some of his observations, but he had written the Paper with the object of arousing criticism.

Polish Iron and Steel Industry.—The Pokoj works in Poland are preparing to start their first mill for rolling tramway rails. Up to the present such rails have had to be imported.

Krupp's Annual Report.—The annual report of the Krupp firm, of Essen, states that the capital of the Company, which in 1914 was 180,000,000 marks, and which was increased in the course of the war and the inflation period to 500,000,000 paper marks, has now been reduced to 160,000,000 Reich marks. The balance-sheet, drawn up in Reich marks, shows reserves of 40,000,000 Rm. No dividend has been paid for the last two years. The report declares that no war material was produced at the Essen works last year, and that since the cessation of passive resistance in the Ruhr orders have been coming in only slowly, and in no way in conformity with the potential output of the works. In order to increase the sale of railway and shipbuilding material Krupps have entered into negotiations with a Spanish shipbuilding firm, and through the Germania yards with a group of Madrid firms. It is further stated that the number of persons employed by Krupps decreased from 97,303 on June 30, 1923, to 71,320 on September 30, 1924.

XUM

Powdered Coal in a Malleable Casting Plant.*

BY F. L. WOLF AND WM. ROMANOFF.

For many years the statement has been heard made by the powdered coal equipment manufacturers that powdered coal was established. A method had been found to extract the maximum number of heat units from one of the oldest fuels, coal. The writers, like many others, were sceptical.

Several years ago the Ohio Brass Company decided to build a new malleable iron plant. When the question of fuel arose they made a thorough investigation, visiting many of the larger plants in this country, and, after considerable thought, decided to try powdered coal. Now, after three years of trial, they not only agree with the powdered coal equipment manufacturers in their statement that powdered coal is here, but they believe that it is here to stay.

Applications of Powdered Coal.

In considering the applications of powdered coal, the authors will merely consider them as they apply to their own plant. In any application the coal demand must be sufficiently large to warrant installation. They employ powdered coal for the melting and annealing of white iron and in the boiler-house. At one time sand cores were baked with powdered coal, but at present oil is being used as a fuel. This change was not made because it was found that oil combustion was cheaper or more efficient, but because in burning pulverised coal a film of ash was deposited upon the cores. Upon inspection for fins or other defects in cores, this film of ash had to be brushed off, with consequent high loss due to excessive breakage. Sand-core breakage is ordinarily large enough without subjecting the core to further hazard by removing the ash. In order to obtain a cleaner core, although not necessarily a better baked core, it was decided to utilise oil for baking.

Suitable Coals.

From various writers and those interested in the sale of pulverised coal equipment the impression was received that almost any grade of coal could be used. But after three years of experience in powdered coal, the authors are more enthusiastic than ever regarding its use, even though they found to their regret that many misleading statements regarding suitable coals are prevalent in the literature.

Since the installation of the powdered coal plant there was the miners' strike of 1922. Like a number of other consumers, the Ohio Brass Company was so desperately in need of coal that they were willing to pay a premium for any black substance that resembled coal and would burn. They used coals with ash contents varying from 2 per cent. minimum to 21 per cent. maximum, with moisture as high as 12 per cent. and sulphur as high as 2 per cent. The moisture could be dried out. At the furnace a reasonable amount of sulphur could be taken care of by adding enough manganese to the metal to offset its deleterious effects, but most foundrymen would admit the futility of trying to melt iron successfully and economically with coal of high ash content, particularly if the latter had a low fusing point. It is continually covering the bath forming an insulating slag and necessitating continuous skimming in order to permit the absorption of the heat by the metal. In addition, the sticky ash adheres to the bungs and bridge wall, reducing the opening between the bridge wall and bungs and setting up a tremendous back pressure which not only makes it very uncomfortable for the furnace men due to the long flame shooting out of the openings of the furnace, but also plays havoc with the refractories. If the opening above the bridge wall is made larger to take care of this condition, an excessive draught results which lowers the efficiency by sucking in cold air through the furnace openings, which in turn chills the metal in passing over same and which also causes some combustion to take place beyond the metal bath instead of on the bath. After each heat the bungs must be raised above the bridge wall and the sticky ash cleared away. This work is very hot and the furnace men suffer considerably. In addition to this there is the delay in melting and the disagreeable feeling of the tired moulders and labourers who are forced to wait for the metal after completing a hard day's work.

In the annealing ovens the ash plugs up the flues with very undesirable results, while in steam boiler practice low fusing point ash will stick to the boiler tubes, thus insulating them from the heat and decreasing the efficiency of the plant.

At present the furnace is using a good grade coal, and an average ratio of 3 lbs. of metal melted per lb. of pulverised coal consumed is being obtained. There are isolated cases where this ratio has gone as high as 4¼ to 1. In the annealing process an average ratio of 3¼ to 4 lbs. of iron per lb. of coal is obtained. Both the melting and annealing coal ratios are considered good practice. It is felt that ash is the most detrimental impurity in coal. This is particularly true in melting if the ash content exceeds 8 or 10 per cent. and has a low fusing point.

Theory of Powdered Coal.

Gaseous fuels are ideal. They can be conveniently distributed, are easily mixed with the necessary oxygen to produce complete combustion and give rise to splendid working conditions. Oil also falls into this class. It is easily atomised and its particles so finely divided that they approach a gas in behaviour when combined with the proper amount of air.

Coal, on the other hand, is usually burned in mass form. Combustion is slow and incomplete and an excess of air is required, the cooling effect of which often neutralises the effect of a more perfect combustion. Consider a cubic inch of coal, for instance, when burned on a grate. Six sq. in. of surface are exposed for combustion. Oxidation proceeds slowly from the surface inward, large excesses of air are required and much carbon is trapped in the ash. On the other hand, if a cubic inch of coal is pulverised so that 85 per cent. will pass a 200-mesh screen, this cubic inch of material will be broken into more than 45 million particles, exposing approximately 30 sq. ft. of surface for combustion. In other words, the more finely the coal is divided, the more nearly it approaches a gas, and in this extremely fine state of division it can be handled very much like a gas. When the fine particles are surrounded with the proper amount of air, at the ignition temperature, instantaneous and complete combustion takes place, with a consequent releasing of all the heat units which the coal contains.

Factors Affecting Powdered Coal Efficiency.

Nowhere in a malleable plant can the merits of a powdered coal system better be judged than at the melting furnace. Here is the pulse of the entire system. Just as a good automobile can be put in disrepute by a poor driver, so can reflection be cast upon a good powdered coal system by inefficient furnace design and operation. Additionally a mediocre powdered coal system can be greatly assisted. As an indicator the time of melting and the coal ratio is used, that is, the lbs. of metal melted per lb. of coal. These can be affected by the factors which are placed under furnace operation.

Furnace Operation—Skimming.

Whether to permit the slag formed to remain upon the metal bath until pouring is a much discussed question. The slag acts as a coating and prevents considerable oxidation, but it has been found that this advantage is greatly offset by the longer period necessary for the metal to reach pouring temperature. There is no question but that slag is a comparative insulator and prevents the heat from reaching the metal. This greatly increases the time of melting in addition to lowering the coal ratio. The practice developed is to skim at least three or four times during a heat and the increased oxidation is taken care of by increasing the percentage of constituents added to the original mix. In other words, suppose 80 points of silicon is desired in

* Paper presented to the American Foundrymen's Association. The authors are connected with the Ohio Brass Company, Mansfield, Ohio.

the finished white iron. In order to obtain this amount one must charge 110 points of silicon. Then it is found that by constant skimming the furnace is giving only 75 points of silicon due to increased oxidation. To offset this added 5 point loss, the silicon charged is merely increased to 115 points.

Rabbling.

Considerable time can be saved in melting by rabbling or poking the charge when it is almost melted flat. This submerges the unmelted iron into the molten bath and permits the heat of fusion of the molten metal to assist in melting. It also exposes more surface to the heat and is quite an important factor in proper furnace operation.

Oxidation.

While an attempt is always made to keep the furnace atmosphere as reducing as possible, still conditions are not found particularly detrimental in so far as the melting time is concerned with an oxidising condition. The reaction taking place upon the oxidation of the white iron constituents is exothermic and the heat generated naturally assists in melting. If increased oxidation occurs, it can be taken care of as explained under "skimming." The only disadvantage in excessive oxidation is the fact that this condition makes the operation of the furnace less "foolproof." It must be closely watched and test plugs must be constantly poured and broken to determine just how far the oxidation of the constituents has proceeded. If the addition of constituents such as silicon or carbon is necessary, it can be taken care of at once instead of waiting until the metal is hot and ready to pour. If the charge is "doped" with silicon, it takes at least twenty or thirty minutes for a thorough intermixing. If the silicon is not, therefore, added at the proper time, it can readily be seen how there would be a subsequent delay, thereby increasing the melting time and necessarily lowering the coal ratio.

Coal.

The quality of coal used also has a tendency either to increase or decrease the melting time and coal ratio.

Cleaning Castings.—I.

Modern Practice and the Draft Regulations.

By A. RUTHERFORD.

Sand Blasting.

For work of large size, or alternatively, of large quantity irrespective of size, sand blasting is probably the most commonly used and the most economical method of cleaning castings. Briefly, the process consists in causing a stream of sand or small iron or steel shot to impinge upon the casting being cleaned, using as the motive power a blast of compressed air.

This and similar processes for achieving the same end have lately been made the subject of an inquiry by the Home Office, and certain tentative regulations have been drawn up which may, at some time in the near future, come into general operation in a modified form. It is with the modern developments of cleaning castings, particularly with reference to these draft regulations, that this and the succeeding articles deal.

The room in which the cleaning takes place is in most plants sufficiently large for one, or perhaps two, men to work inside. Smaller plants are arranged in different ways, but usually the sand blaster operates the nozzles from the outside. In such cases revolving tables are often used. Some tables revolve entirely within the room, others revolve half in and half out, so that castings can be turned or removed as required. Obviously the smaller rooms are best used for cleaning small castings, and the larger rooms, while being suitable for small castings, are primarily intended for large ones.

Sand-blasting rooms are made either of steel plates or, more often, cast-iron plates or sections bolted together. With the room being entirely enclosed, ample electric light must be provided. This may have its source in one or more powerful lamps protected by thick glass domes similar to those used in subways.

Under the proposed regulations the walls, ceiling, and all fixtures in sand-blasting rooms must be cleaned every three months. Further, a register giving particulars of when and how each room has been cleaned, together with the name and address of the cleaner or of the person superintending the cleaning, will have to be kept.

This last provision may seem rather like Governmental "red-tape," but it must be observed that without such a register being kept there could be no truly authentic record of when the rooms were cleaned, should a discussion on the point arise. That regular cleaning is necessary for the good health of the workers is an indisputable fact, since accumulations of sand and dirt provide harbourages wherein noxious growths can flourish undetected, propagating among other things the virulent tubercle bacillus.

It would become compulsory also to damp and sweep the floors of sand-blasting rooms at least once a day. It is fairly safe to assume that there are few works in which the regular routine of cleaning necessary for efficiency does not cover this provision.

Different arrangements are used for supporting the castings while being cleaned. Sometimes a table on a truck is used which can be run in and out of the chamber. In other cases the castings are laid on the floor or on benches inside the chamber. The arrangement must in all cases be laid out to suit the particular kind and size of job operated upon.

An exhausting plant to extract the dust from the room is a vital necessity. This is done mainly through grids in the floor or immediately under the castings being cleaned. An exhauster to maintain a suitable degree of vacuum, about 4 in., is needed, and is usually of the rotary type.

It is specified in the draft regulations that all plant used for the suppression of dust must be examined once every six months. That part of the sand-blasting plant used for separating the sand from the shot may be presumed to be included in this, and a record of inspection will have to be kept similar to that for cleaning.

For the safety of the men employed in sand blasting the question of clothing is of great importance. To protect the body a long and thick coat made of a composition of canvas and rubber is worn, and covers for the feet are made of the same material. To protect the hands, a pair of thick rubber gloves are provided, and for the head a special helmet of leather. This completely covers the head, and an ample soft skirt falls over the shoulders. Sight is obtained through a window in the front. Dust is effectively excluded from this type of helmet by means of a supply of air, conveyed to the top of the helmet by a flexible rubber pipe, at a pressure slightly higher than that in the room. The constant current ensures the interior of the helmet always being entirely clear.

These arrangements for the safety of the worker represent the best modern practice, and are rapidly coming into extensive use. In the draft regulations they are made compulsory, and extra provision is made so that no worker may wear the helmet previously worn by another without it has first been thoroughly disinfected.

SHAREHOLDERS OF Johnson & Phillips, Limited, have approved the amended terms for the reduction of interest on the first mortgage debenture stock. Instead of reducing the interest from 8 per cent. to 5 per cent. per annum from January 1, as originally proposed, it is to be reduced from 8 per cent. to 6 per cent. per annum from July 1, 1925.

THE DIRECTORS of Davy Bros., Limited, have decided to postpone consideration of the payment of the dividend on the preference shares until the final accounts for the year are before them, owing to the unsettled condition of the engineering industry and the difficulty of obtaining orders. They propose to issue first mortgage debentures for £150,000, of which £100,000 have been allotted to replace the £30,000 debentures outstanding and to provide further working capital.

XUM

Institute of British Foundrymen.

Annual Dinner of Birmingham Branch.

The annual dinner of the Birmingham Branch of the Institute of British Foundrymen, held at the White Horse Hotel, Birmingham, on Saturday, January 10, was attended by representatives of a number of kindred bodies. Mr. Thomas Vickers presided. A capital musical and humorous programme was interspersed with the speeches.

The toast of "The Institute" was proposed by MR. T. LOWE (President of the Birmingham Branch of the National Union of Foundry Workers), who emphasised the importance of the technical side of the foundry industry, particularly to the younger men. In his early days, he said, the conditions under which foundrymen had to work were awful. There had been a considerable improvement, and he wanted to acknowledge that although the men had had to work for that improvement, the employers, too, had played their part. He wished the Institute every success.

MR. H. L. REASON (Past-President of the Institute), in response, claimed that the foundry was the birthplace of almost everything great in the world. (Laughter.) From the foundry there came the tiniest pieces of machinery conceivable, while the greatest liners afloat owed their being also to the foundry. When the Editor of THE FOUNDRY TRADE JOURNAL spoke of the foundry as the key of key industries, he thought the phrase was a true one. The troubles that beset the ordinary foundryman were numerous, and through the ages a large amount of work had been done. They were proud as an Institute to have numbered among their members some of the greatest scientists of the day, and they had present that night a gentleman who had rendered yeoman service to the industry in Professor Turner. It was such men of science who had discovered the cause of the troubles which had handicapped the industry, and it was to them that they looked to overcome future difficulties. They wanted to know more about everything they used—sand, coke, and pig-iron. Sands were at last beginning to give up their secret. It was the iron itself which offered the widest field for research, and he believed the foundryman of the future was going to have a very much happier time than those who had preceded him. Started in 1904, the Institute now had a membership of 1,550. At the next Council meeting they would elect one short of 70 new members, which showed that the Institute was a real live organisation. They had an international arrangement with France, Belgium, and America, so that we shared their knowledge and they ours.

True National Wealth.

The toast of "The Foundry Industry" was submitted by MR. W. R. BARCLAY (Chairman of the Birmingham Section of the Institute of Metals), who expressed the opinion that the only way in which our highly skilled industries comprised in the term metallurgical could be made a success was by the kind of co-operation exemplified by the Institute of British Foundrymen. It was an association of skilled workmen and technologists—the chemists and metallurgists who were responsible for directing the industry, and the skilled workmen who were really its backbone in production. It was only by such co-operation that this country could regain its supremacy in the manufacturing industries of the world. He was afraid we ignored far too much the truth that quality, economy, and efficiency of production was the world's wealth. Particularly was that true in the wonderful art of the production of manufactured metals, whether in the foundry, rolling mill, or the engineering workshop. It was by the technologist and the skilled workman working hand in hand with the most complete confidence and the utmost co-operation that successful production would be accomplished. That was the true wealth, and he feared we were spending far too much time in discussing the distribution of wealth and all the time very seriously losing ground in the actual creation of wealth.

MR. JAMES FINNEY (President of the Birmingham Association of Mechanical Engineers), in reply, contrasted conditions to-day with those obtaining in the past. In the old days, he said, the patternmaker was considered a necessary evil and no sort of profit to an engineering undertaking. He was afraid the moulder had even less consideration. He was put to work in any old shed, and the employers did not worry so long as the moulds were not spoilt. Even in those days, however, there were some very fine craftsmen. To-day conditions were very different, and in modern works the foundry was as comfortable and almost as clean as the fitting shop. The conditions of work were practically as good, and it was necessary in these days of quantity production that better conditions should prevail. There was still much to be done, but the job was being tackled on the right lines. To-day we could compete with the world, and could turn out as good cylinder castings as any other country.

Birmingham's Part in Foundry Technical Development.

PROFESSOR T. TURNER (President of the Institute of Metals), in proposing the toast of the Birmingham Branch of the Institute of British Foundrymen, recalled that some twenty years ago Birmingham members took a very important part in the formation of the parent Institute and furnished it with Presidents, such as the late Mr. Robert Buchanan and Mr. F. J. Cook, and in that way influenced the policy of the Institute. The work of the Institute represented a basal industry in connection with civilisation, and in illustration of the point he might quote the motto of the Metallurgical Department of Birmingham University, "The hand that wields the ladle rules the world." The work of the Institute was done chiefly by means of the branches. It was true that there was an annual meeting at which certain business was transacted and a few Papers were read, but the greater number of Papers and the greater part of the discussion came within the purview of the various branches. The branches performed a very useful and important function in the districts in which they were placed. They brought together men interested in the foundry industry, which in itself was a great thing. Friendships out of business hours resulted, they had an interchange of notes and experience, and, instead of being competitors, they felt that they were united as members of a great industry. The importance of scientific knowledge united with the practical skill of the craftsman had been realised in recent years more than ever before. The meetings afforded an opportunity for the theoretical and the practical to gain from each other. If foundrymen received no personal benefit, it was to their interest as human beings and citizens to study the reason why they did things and the principles underlying their occupation. He could imagine few things more uninteresting than mass production without reason—a person doing the same old thing in the same old way at the same old price and having nothing to look forward to during the whole of his life but doing that same thing.

MR. THOMAS VICKERS (President of the Birmingham Branch), responding, said the Branch covered a wide area, having under its jurisdiction five Midland counties and going as far south as Bristol. In that area there were over 900 foundries. The membership of the Branch was a little under 200, but it ought to be not less than 500. They ranked fourth or fifth in the list of Branches, and it was their ambition, whether this year or next year, to make the Branch rank first. But if they were small in numbers, they considered that the Branch was about the most active of the whole of the ten Branches. He regretted the indifference of some ironfounders to the work of the Institute, remarking that if they would come to the meetings they would realise the personal benefit likely to be derived from membership. If as an Institute they

could extend the technical knowledge of the workmen, surely they must be benefiting the proprietor. But the work of the Institute through the Branches did not stop there. They were trying, in addition, to get the workman to take some pride in his craft. (Applause.)

"Kindred Associations" was submitted by MR. W. LAWSON (Chairman of the South Midland Centre of the Institution of Electrical Engineers), who expressed the conviction that if employers and employed came together this country would lead the world in industry. We had been, and might still be, supreme as originators in the utilisation of the forces and the resources of nature, but as competitors we had nothing now to throw away.

MR. ASKWITH ELLIS, Hon. Secretary of the local Branch of the Institution of Mechanical Engineers, in reply, said there were about 26 technical societies in the Birmingham and Midland area whose close co-operation was of importance not only to the district but to the nation. In London such co-operation was difficult, but it was quite fitting that some system of co-operation should emanate from Birmingham, and he sincerely hoped that matters in this respect would come to a head. The civil, electrical, and mechanical engineers were at present working towards that end in the Birmingham Centre, and no one could tell what the future would bring forth from that initial effort.

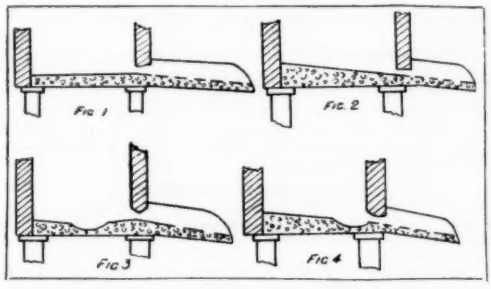
MR. H. B. JACKS (President of the Staffordshire Iron and Steel Institute), whose name was also associated with the toast, agreed as to the value of co-operation between the scientific societies, and said there never was a time when there was less antagonism to the idea.

The toast of "The Ladies" was given by MR. J. B. JOHNSON, a Past-President of the Birmingham Branch, and MRS. ARTHUR MARKS made a graceful response.

Tapping Holes.

By J. E. P.

Tapping holes when badly made will cause a very considerable amount of trouble, and sometimes very serious trouble and involving serious monetary losses. When the first melted metal trickles down and falls upon the bottom of the cupola it runs toward the tapping hole, which, if badly made and not properly dried, will cause the metal to solidify in the hole, forming what is commonly called "bone-in-the-hole." Then sledge-hammers and bars are brought into use in the endeavour to remove this solid metal from the tapping hole by driving it into the cupola. If success attends the effort, invariably the tapping



hole is made much larger than it originally was. This makes it very difficult to bot-in properly during the whole of the cast. This "bone-in-the-hole" more often occurs at the first tap than at any other time, and if it is not mastered, the metal melts and collects in the cupola until it reaches the wind belt, and will run out through the tuyeres, especially if the wind is not shut off and the melting stopped.

Many furnacemen still adhere to the old method of leaving the tapping hole open and blowing some metal through before stopping up. This is rather a bad system, and is not too clean, and additionally, it sometimes makes a mess of the tapping hole and spout.

It has happened in most foundries some time or another that this trouble has had serious results, as, after stopping the blast and hammering away at the tapping hole, the "bone" could not be moved. Then it was decided to drop the bottom and clear the cupola, but first all the molten metal must be removed. This can be tapped out through the breastplate at the back of the cupola. After the metal is out, the cupola may be more or less "bunged up," and there may be trouble in getting out this semi-molten and unmelted metal, long bars being used to poke up the cupola and through the tuyeres, and often the mass has to be left in the cupola until it cools down, as the men cannot stay long near the great heat of the hot material which has been drawn.

If ordinary care is taken in making up the bottom of cupola and the tapping hole, all this trouble and mess will be avoided.

Fig. 1 shows the old method of making the bottom and tapping hole. It will be noted that the bottom is flat and the hole is long.

Fig. 2 is the next step, showing the bottom slanting toward the tapping hole. This method was especially adopted to drain all the metal out of the cupola before dropping the bottom.

Fig. 3 is yet another step forward, showing the bottom slanting toward the centre, with a small dip into which the first molten metal will run, so keeping the tapping hole free from this first metal, which is not so hot as later.

Fig. 4 is another method aiming at the same desirable result.

The tapping hole should be made of some strong refractory material and thoroughly dried. Then all that is needed just before starting to blow is a little dry blacking tucked into the hole and backed up with a little floor sand. Then, when the metal is ready to be tapped, this stopping can very readily be removed, and the cast will be clean all through the day, so far as the tapping hole is concerned.

Of course, there are other causes for the metal setting in the tapping hole, *i.e.*, bad coke, too heavy charges of iron, the oft-mistaken idea of saving coke by putting too little to each charge of iron. Skimping coke is a false economy.

Good tapping hole, clean tuyeres, and ample coke are basic necessities for the production of proper metal.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

The New Salesmanship.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I shall esteem it a favour if you will allot me space in your valued medium to return a few compliments to "Quiz."

In the first place, I am pleased to see that he only criticises a few foundry suppliers' methods, but apart from viewing them "from a purely British standpoint," he seems to have let off a large volume of Yankee gas, which, no doubt, has previously been "trapped" beneath his poor breakfast, lost contracts, or the skin of his waste castings.

Anyhow, like many other foundrymen of 20 years' (and over) standing, he is of the opinion that "our expert" is simply an empty term used by all foundry suppliers, but bearing in mind that the comments are not unwarranted, there are as good foundrymen outside the foundry as there are in.

Speaking personally, although far from an expert, in the right sense of the word, I have had experience in many branches of foundry work, and have left the foundry, taking with me the cream of the knowledge gained by foundrymen of 20 years' experience, who have been in the same rut since their apprenticeship commenced.

I think the object upon which "Quiz" meant to comment was the modern method of competition, in which the foundry supplier is very modest, compared with "Quiz's" food, clothes, and other requisite suppliers.

To conclude, I invite him to allow me an interview, or a demonstration of my lines, when next his way, and I might be able to show him that "our experts" know a little bit, after all, and I hope the "revenge" of supplying him will be "sweet" for us both.

Yours, etc.,

"COMMISSION ONLY."

[This letter has been abridged somewhat.—ED.]

Trade Talk.

LAUNCHES ON THE Tyne last year totalled 64, of 254,384 gross tons, an increase of 18 vessels and 121,442 tons on the previous year.

A LICENCE UNDER THE Non-Ferrous Metal Industry Act (1918) has been granted to the British Copper Manufacturers, Limited, 4, London Wall Buildings, London, E.C.2.

THE BRITISH INSULATED AND HELSBY CABLES, LIMITED, of Prescott, Lancs, propose the addition of a new cable shed, 520 ft. long by 124 ft. wide, in one span, to their works.

JOHNSON, MATTHEY & COMPANY, LIMITED, Hatton Garden, London, E.C.1, have acquired the business of Richard Buckland & Son, Limited, Hadyn Park Works, Shepherd's Bush, W.12.

THE BRITISH EMPIRE STEEL CORPORATION contemplates the closing down of some of its iron ore mines in Bell Island, Newfoundland, in consequence of contracts for the 1925 trade not having yet been made.

A SYNDICATE OF PROMINENT Canadian financiers have acquired control of the Canadian Car & Foundry Company, hitherto held by the American Car & Foundry Company. Mr. W. H. Woodin, president of the American Car & Foundry Company, retains his personal interest in the company and remains on the board of directors.

FLEMING & FERGUSON, LIMITED, engineers and shipbuilders, Paisley, have received an order from New Zealand for a large floating crane steamer having an 80-ton lifting capacity steam crane. The crane is to be supplied by Sir William Arrol & Company, Limited, Glasgow. The Paisley firm have also secured an order for a sand suction dredging and reclamation plant, complete with floating pipe line, for work at Gambia, West Africa. An order for three Canadian Lake steamers has been secured by Swan, Hunter, Wigham Richardson, Limited, of Wallsend.

REPORTS RECEIVED from Sao Paulo, Brazil, announce that in a competition opened by the Sorocabana Railway for the delivery of 59 locomotives of the Mikado and Pacific types, most of the contracts have been allotted to German firms. The Fried. Krupp concern, which is said to have submitted the most favourable offer, has been awarded an order for 40 of the locomotives required, and the firm of Richard Hartmann & Company an order for 10 locomotives. The contract for the remaining 9 engines has been given to the American Locomotive Company. It is added that further orders for 20 locomotives as well as for passenger coaches are pending.

THE TATA IRON & STEEL COMPANY are inviting shareholders to advance to the company ten rupees or more for each share held. The money so advanced is to receive interest at 8 per cent., and, in addition, a share in the profits from next April in the proportion of 10 per cent. of the profits on one crore, and less proportionately. Thus, if the loan raised were one crore, 10 per cent. of the profits would be payable to certificate debenture-holders, additional to 8 per cent. interest. If the loan amounted to 90 lakhs, 9 per cent. of the profits would be payable; if the loan were 80 lakhs, 8 per cent., and so on. Such profits are ascertainable after deducting 30 lakhs in respect of depreciation. The additional production and additional revenue expected from the company's extensions are now beginning to materialise, and it is expected that revenue will increase still further until full production is reached. The additional working capital is required owing to increased production.

Company News.

Kayser, Ellison & Company, Limited.—Interest warrants for six months' interest on preference shares to December 31, 1923, will be paid at end of January.

John Shaw & Sons (Wolverhampton), Limited.—Profit, £18,693; brought forward, £25,353; available total, £44,046; dividend for year, 7½ per cent., less tax; carried forward, £29,008.

Steel Supply Company, Limited, Abbey House, Victoria Street, Westminster, S.W.1.—Capital £22,000 in £1 shares. Iron, steel and metal merchants, engineers, ironfounders, etc. Directors: G. Levy (chairman), 3, Hollycroft Avenue, N.W.3, iron and steel merchant; B. Cohen, J. Peech, W. Seaman (addresses not stated); Major A. E. Lloyd, 46, The Drive, Ilford, Essex, merchant. Messrs. G. Levy and B. Cohen are deemed to have been nominated by George Cohen, Sons & Company and Messrs. J. Peech and W. Seaman by the United Steel Companies, each of which companies, while holding 8,000 shares, has the right to appoint his successor.

Nova Scotia Ore for Germany.—Shipments of iron ore by the British Empire Steel Corporation to Germany during 1924 totalled about 806,000 tons, or nearly 70,000 tons more than in the previous year.

Personal.

SIR HUGH BELL, BART., has been re-elected chairman of the Cleveland Mine Owners' Association, with Sir Arthur F. Pease, Bart., and Mr. W. W. Storr as vice-chairmen.

SIR ROBERT HORNE, chairman of the National Smelting Company, Limited, Sir Henry Strakosch, Mr. F. A. Govett, Sir Cecil L. Budd, joint managing director of the British Metals Corporation, and Mr. A. Chester Beatty have been elected directors of the Burma Corporation, Limited.

MR. A. W. A. CHIVERS (British Electrical Federation, Limited) has been re-elected president of the Diesel Engine Users' Association for the year commencing January 1. Messrs. C. M. Mayson and J. G. Griffin have been elected to fill the vacancies on the general committee of the Association, and Messrs. P. Still and G. Porter have been re-elected joint honorary secretaries.

SIR WILLIAM H. ELLIS, president of the Iron and Steel Institute, who last week visited South Wales as the guest of Mr. Spence Thomas (president of the South Wales Institute of Engineers), paid a semi-private visit to Swansea on January 14 preparatory to proceeding to Cardiff, where he was the principal guest of the South Wales Institute at its annual banquet on Thursday, January 15. Sir William, accompanied by Mr. Spence Thomas, was received by Mr. Lewis Jones (secretary of the South Wales Siemens Steel Association). After luncheon Sir William inspected Messrs. Baldwins, King's Dock, tinplate works, and afterwards was shown over the British Mannesmann Steelworks. In the evening Sir William was privately entertained at a banquet at the Hotel Metropole by the South Wales Siemens Steel Association. The chair was taken by Mr. F. W. Gilbertson (president of the association), who was supported by Mr. Spence Thomas and Sir J. C. Davies (vice-president of the association).

Contracts Open.

London, S.W., January 27.—269,148 steel dogspikes (approximate weight 79 tons) for use with flat-footed rails (B.S.) 90 lbs. per yard, and 150,000 steel dogspikes (approximate weight 40 tons) for use with flat-footed rails (B.S.) 60 lbs. per yard, for the Madras and Southern Mahratta Railway Company, Limited. The Offices, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee, £1 1s., non-returnable.)

Pretoria, S.A., February 2.—The Municipality of Pretoria invite tenders for supply of cast-iron pipe fittings, valves and surface-boxes. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference A.X. 1631.

Stockholm (Sweden), January 30.—According to Reuter's, 5,000 metres of steel rails, for the Malmoe Hamnfoervaltning, are required.

Cairo, February 15.—The Egyptian Ministry of the Interior require supply and erection of pumping plant. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference No. A.X 1591.)

Southampton, February 16.—Supply and erection of two triple-expansion pumping engines, well and force pumps, etc., each set to be of a capacity of six million gallons per day of 24 hours against a head of 280 ft., for the Corporation. Mr. E. C. Rodda, waterworks engineer, 21, Shirley Road, Southampton. (Fee, £5 5s., returnable.)

Obituary.

MR. A. WAINWRIGHT died on the 8th inst., at Fern Lea, Stocks Lane, Stalybridge, in his 74th year. He was senior partner in Thomas Wainwright & Sons, engineers, Stalybridge.

MR. W. G. LECOMBER, head of the firms of T. Ryder & Company and A. Harrison & Company, engineers, Knott Mill, Manchester, has died at his home in Ruthin, North Wales, aged 55.

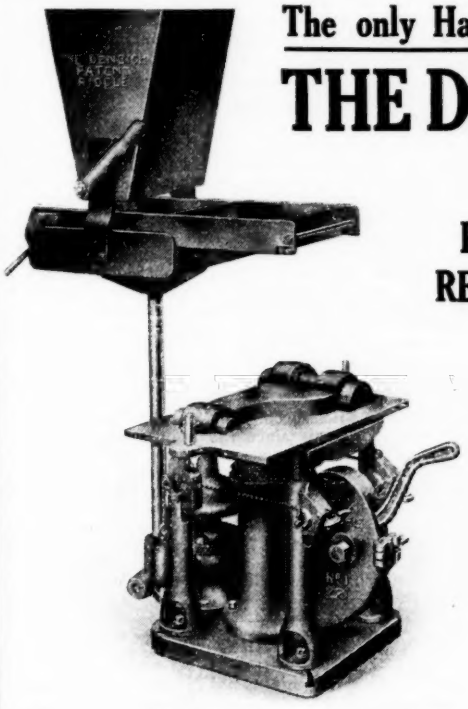
MR. J. FORRESTER, engineer, has died at his residence, Inveresk Place, Coatbridge. He served his apprenticeship with William Baird & Company, Limited, Gartsherrie Ironworks. He was for a time manager of the Dalmeny Oilworks, a position he relinquished to take charge of the Constructional Department at the Forth Bridge. This charge he maintained until this great engineering feat was completed. On returning to Coatbridge he was appointed manager of the Sun Tube Works.

THE BOVING ENGINEERING WORKS, LIMITED, are being wound up voluntarily, with Mr. D. M. Touche, chartered accountant, as liquidator.

The only Hand Jolt Ramming Machine in the world

THE DENBIGH "MARVEL"

NO POWER REQUIRED



M/C	Takes Boxparts		Load anyweight	Pattern Draw
No. 0	10 to 12" wide	× Any reasonable length.	to 1½ cwt.	4"
1	10 to 14" ,,		,, 3 ,,	and
2	10 to 16" ,,		,, 5 ,,	6"
3	12 to 20" ,,		,, 9 ,,	8"
4	16 to 30" ,,		,, 15 ,,	up to
5	18 to 36" ,,		,, 20 ,,	24"

M/C	Takes Boxes	Load	Pattern Draw
No. 0	12" wide 16" long	1½ cwt.	6"
1	16" ,, 24" ,,	3 ,,	6"
2	18" ,, 30" ,,	5 ,,	6"
3	22" ,, 36" ,,	9 ,,	8"

For further particulars apply:

The DENBIGH ENGINEERING Co., Ltd.
Horseley Heath, TIPTON.
'Phone: 86. *'Grams: "Denbigh."*

Telephone: 2000. *Telegrams:* "FOUNDERS," NEWPORT

JORDANS LIMITED

Successors to CHARLES JORDAN & Co. Established 1849.

- Pillgwenlly Foundry -
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Manufacturers of all descriptions of

CAST IRON PIPES,

Special Flanged Castings.
General Engineering Castings,

INGOT MOULDS.

THOS. GADD,

ROSS BOLT, NUT, and RIVET WORKS,
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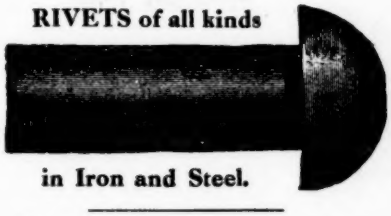
RIVETS of all kinds

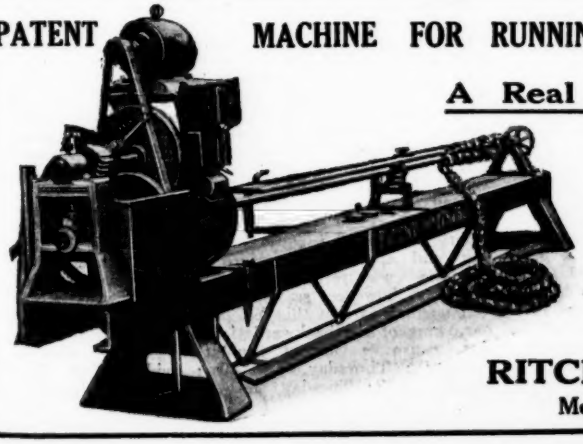


in Iron and Steel.

Telegrams—"Thos. Gadd, Rowley Regis."
Telephone—No. 90, Halesowen. [Estab. 1830.

PATENT MACHINE FOR RUNNING LOAM CORES ON BARRELS

A Real Labour Saver.



Cores any length and diameter, OPERATED BY ONE MAN. Driven by motor or countershaft. Machines in use for cores 28 ft. × 30 in. diameter. Patent No. 178750.

Testimonials from Iron and Brass Founders.

RITCHIE HART & CO., LTD.
Mount Pottinger Foundry, BELFAST.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron trade have made, so far, little progress towards increased activity, and, admittedly, the anticipations of an early improvement in home and export demand are not yet much nearer to actual realisation. It must, however, be remembered that buying on the Tees-side market before the close of the year was on a fairly heavy scale, and at the moment furnace outputs are going steadily into consumption, while an early recovery of the foundry trade demand would unquestionably necessitate an increase of the plants in operation. On the export side, the position remains unsatisfactory, the market abroad being considerably undercut by Continental makers, and unless prices of Cleveland iron can be substantially reduced, the hopes of recovery of foreign trade are, unfortunately, remote. In the meantime prices are again easier, No. 3 G.M.B. being on offer last week at 80s. per ton, with No. 1 quoted 85s., No. 4 foundry 79s., and No. 4 forge 78s. per ton.

Business in the hematite trade is on the quiet side, consumers in the home market have apparently adopted a waiting attitude for the present, and there is but little new buying of any moment. The quotation for East Coast mixed numbers now stands at 87s. per ton, with West Coast Bessemer mixed numbers at 98s. 6d. per ton at Glasgow, 102s. 6d. per ton at Sheffield, and 106s. 6d. to 108s. per ton at Birmingham.

LANCASHIRE.—Only a moderate demand is reported for foundry iron in the Manchester market, but the prices remain steady for the leading makes. Unfortunately, the revival of demand for castings in this locality has not materialised, and business is consequently on a restricted scale. Local sellers of Derbyshire pig-iron are quoting 90s. delivered for foundry quality, and so far as can be discovered they are not short of orders for this quality.

THE MIDLANDS.—The outlook for the foundry iron trade in this district is now regarded as more favourable, and a fair amount of buying is in evidence in the market. Quotations are also steady as follow:—Derbyshire No. 3 foundry, 82s. to 82s. 6d.; Staffordshire No. 3 foundry, 87s. 6d.; Northants. No. 3 foundry, 76s. to 77s.

SCOTLAND.—Movements in the markets for Scotch pig reflect little change in the general position, which continues unsatisfactory, with few signs of an early improvement. The price of No. 3 foundry remains nominally at 90s. per ton at the furnaces, but merchants are prepared to cut this price in order to get rid of stocks. Deliveries are not going away to the extent that the makers had hoped, and the question of reducing the production is again receiving very serious consideration in more than one direction.

Finished Iron.

In the manufacturing sections of the iron trade makers of marked bars are fairly well placed for orders, and the outlook in this direction remains quite good. The mills catering for this class of material have seen a steady improvement in trade during the last few months, due to a large extent to the activity in the wagon-building trade, and, with further orders being placed by the railway companies, the prospects for the next few months are distinctly good. The price of £15 f.o.t. makers' works is maintained, and it is not thought there will be any alteration in this figure, which has been operative since last year. It is not possible to report anything of an encouraging nature in respect of crown bars or the cheaper quality of nut and bolt iron. The makers of these grades feel very intensely the effects of the Belgian competition, and of late years steel bars have been used in many cases where formerly iron bars were employed. At the present time the price for steel bars is £2 10s. below the current figure for crown iron, which is now quoted at £12 10s. to £12 15s. delivered local stations, while nut and bolt iron is quoted at £11 15s.

Steel.

It is becoming increasingly difficult to hold the optimistic opinions expressed a short time since in regard to improvement in the steel industry, in which a lack of orders and inquiries apparently continues to delay recovery. The market for semi-products is also on the slow side, while in the case of ferro-alloys the general attitude is to be very cautious in buying, and there is little activity in the market. Forward business is slow, and there is no buying except to meet immediate requirements. The general conditions in the tinplate trade are practically unchanged, though the outlook from the industrial point of view is improving, and there are more inquiries coming along, especially from the Continent, for Welsh brands. The Far East is also a good buyer. Business generally has been on the schedule rate of 23s. 6d. basis, I.C., f.o.b. Bristol Channel ports, and works are now sellers at this figure.

Scrap.

Demand for this class of foundry material continues flat, and for the time being business is confined solely to the satisfaction of more immediate requirements. In Lancashire, dealers in foundry scrap are fairly firm, and as a rule from 85s. to 90s. per ton delivered is asked for good lots of cast-iron scrap, but there is a good deal of this material about, and some of it is in the hands of weak dealers, who are rather apt to spoil the market. The local ironfounding trade is far from brisk, and the prices for castings are cut in the scramble for orders, so that foundry owners have to economise when buying the raw material, and, as they cannot force down the price of pig-iron, they attack the more vulnerable prices of cast scrap. In Scotland, machinery cast-iron scrap is firmer, and sellers ask 90s. to 92s. 6d. per ton, but very little has yet changed hands since the holidays. Ordinary heavy cast iron to the same specifications, i.e., pieces not exceeding 1 cwt., suitable for foundries, is around 85s. to 87s. 6d. For cast-iron scrap in larger pieces 85s. per ton is quoted, and for old cast-iron railway chairs 90s. per ton. Light cast-iron scrap is still in good demand at 75s. to 77s. 6d. per ton, and, if mixed with firebars, 2s. 6d. per ton less. The above prices are all per ton delivered, f.o.t. consumers' works.

Metals.

Copper.—Values of this metal continue steadily maintained, the fluctuations daily recorded pointing, if anything, to the influence of an improved demand on American and Continental account. While business with users in this country has not broadened out to a material extent, it is evident from the trend of affairs in the consuming industries that full supplies will be needed during the present year. The British stocks are certainly heavier on the month at 38,419 tons, but the bulk of this is rough copper. Current news from Germany intimates that metal interests there are buying copper, and that American bankers are financing the operations. The idea apparently is to hold a stock of copper in Germany. Current quotations :—*Cash* : Thursday, £66 7s. 6d.; Friday, £65 17s. 6d.; Monday, £65 17s. 6d.; Tuesday, £65 5s.; Wednesday, £64 2s. 6d.

Three Months : Thursday, £67 10s.; Friday, £67; Monday, £67; Tuesday, £66 5s.; Wednesday, £65 15s.

Tin.—Movements in standard tin during the past week developed a slightly weakening tendency in values, due probably to realisations by speculative interests, although the general position in the market is inherently strong. The present relatively high prices, of course, have, to some extent at least, discounted a prospective enlarged consumption. The American deliveries, which for December were rather poor, will undoubtedly experience a large increase this month. There is plenty of tin afloat to America, but fresh arrivals are rather badly needed since the American stocks dropped very low. The Straits shipments for December were very heavy at about 8,100 tons, which, combined with the small American outgoings, chiefly explained the unusually big swelling of the visible supply. Current quotations :—*Cash* : Thursday, £265 10s.; Friday, £259; Monday, £259 5s.; Tuesday, £259; Wednesday, £255 15s.

Three Months : Thursday, £269 15s.; Friday, £263; Monday, £263 5s.; Tuesday, £263; Wednesday, £259 12s. 6d.

Spelter.—Conditions in this section of the market, though indicating slight weakening of current values, are fairly steady, and the undertone is good. Generally speaking, the trade here does not rush to buy, but may do so later. Rates look high enough, but the market is in firm hands, and possibly a higher range will be seen during the next month or two. Supplies here are very moderate at 400 tons. Current quotations :—*Ordinary* : Thursday, £38 12s. 6d.; Friday, £37 10s.; Monday, £37 18s. 9d.; Tuesday, £38; Wednesday, £37 7s. 6d.

Lead.—The market for soft foreign pig continues steady, with little change in the position as previously reported. Buying in any tonnage at present is difficult and appears to require greater setbacks than was the case recently to stimulate new business. Probably, however, seasonal requirements play a not unimportant part in this feature, and also the gradual narrowing of the backwardation may be attributed to this cause. Current quotations :—*Soft foreign (prompt)* : Thursday, £43 10s.; Friday, £42 10s.; Monday, £42; Tuesday, £41 12s. 6d.; Wednesday, £39 12s. 6d.